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FROM NAI(T1) DETECTORS FOR THE ND6620 COMPUTER(U) NAVAL
RESEARCH LAB WASHINGTON DC G W PHILLIPS 08 MAY 85

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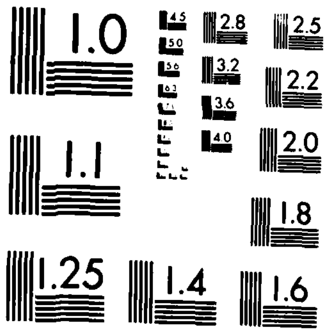
1.0
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NRL Memorandum Report 5541

Kalman Filter
Time Series Analysis of Gamma-Ray Data from NaI(Tl) Detectors for the ND6620 Computer

G. W. PHILLIPS

Radiation Detection Section
Condensed Matter and Radiation Sciences Division

May 8, 1985

NAVAL RESEARCH LABORATORY
Washington, D.C.

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The Kalman Filter technique is applied to time series gamma-ray data from NaI(Tl) detectors. A set of standard spectra which contribute significantly to the data in the least-squares sense are first determined using regression analysis. The Kalman Filter computer program is then used to determine the time behavior for the intensities of the standards which contribute to the observed spectra. The program was written for the ND6620 computer in DEC RT-11 FORTRAN and is being transferred to the VAX 11/780.

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CONTENTS

KALMAN FILTER
TIME SERIES ANALYSIS OF GAMMA-RAY DATA FROM NaI(Tl) DETECTORS FOR THE ND6620 COMPUTER

INTRODUCTION

This program is intended for use on time series gamma-ray data from NaI(Tl) detectors. It is used in conjunction with the PAGSCN Data Screen[1] and the PREGA Regression Analysis[2] programs. The data consists of consecutive 256 channel gamma-ray spectra, each collected over a unit time period. Program PAGSCN screens the data for bad records and system malfunctions. The data are then summed over time into background and source spectra. Program PREGA is used to do a pivotal regression analysis of the source spectrum to a library consisting of the background plus a set of standard spectra. PREGA determines the subset of the library which gives the best fit to the source spectra in the least-squares sense. The Kalman Filter is then used to determine the time behavior for the intensities of the library spectra as components of the source spectrum.

PREPARATION FOR KALMAN FILTER

The analyst should be guided by the results of the PREGA least-squares analysis in selecting library sources for use in the Kalman Filter. In general, the background plus the sources found to be significant in the least-squares analysis will be used. Additional library sources may be included to check for possible interferences or correlations with the data. The gain and zero offset of the library spectra must be adjusted using Program GSHIFT[2] to match the values obtained from the energy calibration of the background. It is assumed that these values do not change between collection of the background and the source spectra.

THEORY OF OPERATION

The Kalman Filter[1,2] provides an adaptive minimum variance estimate of the intensities of the various library spectra in the source spectrum at each 10 second record. It makes optimal use of a priori data from the results of the previous measurements and combines this with the current results to get a best estimate for the source intensities x_k at time k and their covariances P_k, given the observed spectra $y_1, y_2, \ldots, y_k$.

The filter operates on a system model shown in Fig. 1 which relates the source intensities x_k at time k to the observed data y_k. The response matrix S_k describes the response of the detector system to the signal from the source. The expected output of the system is $S_k x_k$. Added to this is a system noise vector v_k which includes the random statistical variations in the detector system. The result is the observed system output

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y_k. Generally the system noise v_k is assumed to be gaussian with a mean of zero and covariance R_k which is known or can be estimated.

The behavior of the source between times k and k+1 is assumed known and is modeled by the transition matrix H_k. The expected output is $H_k x_k$. Added to this is the input noise vector u_k which represents variations in the source intensities due to unknown effects or inadequacies in the model. The result is the vector x_{k+1} giving the source intensities at time k+1. The input noise is also generally assumed to be gaussian with zero mean and covariance Q_k which is known or can be estimated. Note that the input noise u_k drives the system, which is otherwise completely determined by the initial conditions x_0 and the transmission matrices $H_0, H_1, \ldots, H_k$. Were it not for the input noise, our knowledge of the source vector x_k would continue to improve with each observation, and its covariance P_k would continued to decrease.

Given the above model, the Kalman Filter shown in Fig. 2 provides estimates for the source intensities $\hat{x}_{k/k-1}$ and covariance $P_{k/k-1}$ and for the expected system output $\hat{y}_k = S_k \hat{x}_k$. These are compared to the observed data y_k. The difference between observation and prediction is fed back with a gain K_k to provide a corrected estimate given by

$$\hat{x}_{k/k} = \hat{x}_{k/k-1} + K_k[y_k - \hat{y}_k].$$

The magnitude of the Kalman gain K_k depends on both the input covariance $P_{k/k-1}$ and the output covariance R_k.

At time step k, we begin with a priori estimates represented by $\hat{x}_{k/k-1}$ and $P_{k/k-1}$ based on data up to and including y_{k-1}. The updated a posteriori estimates, including the knowledge of the data y_k, are then given by

$$\hat{x}_{k/k} = [I - K_k S_k]\hat{x}_{k/k-1} + K_k y_k$$

$$P_{k/k} = [I - K_k S_k] P_{k/k-1}$$

where I is the diagonal identity matrix, and the Kalman gain

$$K_k = P_{k/k-1} S_k^T [S_k P_{k/k-1} S_k^T + R_k]^{-1}$$

where R_k is the diagonal matrix given by the Poisson variances in the data y_k.

The response matrix S_k is made up of elements $S_k(I,J)$ giving the response of the detector system in channel I to a unit source of type J. The columns of S_k thus contain the library spectra, and the elements $\hat{x}_k(J)$ contain the estimated intensities of source J at time k. We will assume that the system response does not change with time so that S_k is a constant matrix for all times k.

To obtain a priori estimates at time k+1, we can write

$$\hat{x}_{k+1/k} = H_k \hat{x}_{k/k}$$

$$P_{k+1/k} = H_k P_{k/k} H_k^T + Q_k$$

The transition matrix H_k represents the known time behavior of the system, which we will take as constant so that $H_k = I$, the identity matrix. The input noise matrix Q_k, which we will take as diagonal, represents modeling errors and other unknown variations in the source term x_k. We will take it to be proportional to the square of a weighted mean $\bar{x}_k$ for times 1,2...,k

$$Q_k(I,J) = \delta_{IJ} \, q_0(J) \, \bar{x}_k(J)^2$$

or optionally, fix it at its value at some time k0,

$$Q_k = Q_{k0} \text{ for } k \geq k0.$$

Currently we use $q_0(J) = 0.1$ for background and 0.3 for the rest of the library.

For a constant background and small input noise, the system will rapidly approach good estimates for x and P, regardless of the chosen initial values of x_0 and P_0. If the signal then changes due to a real source, it will take several time steps to obtain good estimates for the new values of x and P. The magnitude of the input noise term Q relative to the output noise R determines how fast the filter can adjust to a change in the signal. A small Q leads to greater memory and thus smoother variations in the estimates x. A large Q leads to less memory resulting in a more immediate influence of a change in the observed data y and thus larger variations in the estimates $\hat{x}$. This is discussed in more detail below in the section on "Filter Tuning."

To start the filter we use initial values $\hat{x}_{0/-1}$ of 1.0 for background and equal to their estimated standard deviations for the other library members. We assume an initial error of 100 percent so that the initial variance is

$$P_{0/-1}(I,J) = \delta_{IJ} \, \hat{x}_{0/-1}(J)^2$$

To obtain output intensities in terms of standard deviation units, we calculate a normalized source term

$$n_k = (\hat{x}_{k/k} - \bar{x}_k)/v_k^{1/2}$$

where the weighted mean uses an iterative exponential weighting with constant slope, a, given by

$$\bar{x}_k = (a_k\ \bar{x}_{k-1} + \hat{x}_{k/k})/b_k$$

where the constant in the numerator

$$a_k = \sum_{j=0}^{k-1} a^{(k-j)}.$$

In the denominator

$$b_k = a_k + 1$$

$$= \sum_{j=0}^{k} a^{(k-j)},$$

so that $a_{k+1} = a\ b_k$. The numerator is equivalent to

$$\sum_{j=0}^{k} a^{(k-j)}\hat{x}_{j/j}$$

so for the constant slope, a, less than one we have exponentially declining weights as we go back in time. For large k we approach the limits

$$\lim_{k\to\infty} a_k = a/(1-a)$$

$$\lim_{k\to\infty} b_k = 1/(1-a).$$

An exponentially weighted variance, v_k is also calculated for $\hat{x}_{k/k}$, by

$$\bar{u}_k = (a_k \bar{u}_{k-1} + \hat{x}_{k/k}^2)/b_k$$

$$v_k = \bar{u}_k - (\bar{x}_k)^2.$$

FILTER TUNING

To further examine the effects of the parameters q_0, consider the terms in the brackets for the expression for the Kalman gain

$$K_k = P_{k/k-1} S_k^T [S_k P_{k/k-1} S_k^T + R_k]^{-1}.$$

For the output noise R_k negligibly small, we note that

$$K_k \approx S_k^{-1}$$

$$\hat{x}_{k/k} \approx S_k^{-1} y_k$$

In this limit, the updated estimates depend only on the response matrix S_k and the observed data y_k at step k. All information prior to step k is ignored.

For negligibly small input noise, $P_{k/k-1}$ becomes negligibly small and the first term in the brackets can be neglected. Then

$$K_k \approx P_{k/k-1} S_k R_k^{-1} \approx 0$$

$$x_{k/k} \approx x_{k/k-1}$$

In this limit, the updated estimates depend only on the a priori estimates and the observed data y_k is ignored. The filter will tend to diverge from the data over time.

The input covariance estimate $P_{k/k-1}$ is kept from becoming negligibly small by the addition of the input noise matrix Q_k at each time step. Thus the filter is driven by the input noise. If Q is too small, the estimates will tend to diverge from the data. If Q is too large, they will depend only on the last observation, ignoring all previous data. The values of q_0 recommended in the previous section can be decreased or increased

dependi^^ on the amount of smoothing desired in the estimates as they vary with time.

PROGRAM KLPREP

Operation

This program reads the data tapes, extracts the gamma spectra, record ID, and MODE, condenses the gamma spectra from 256 to a fewer number of channels (typically sixteen) and writes the results to a disk file for use by the Kalman Filter.

Language

The program is written in DEC RT-11 FORTRAN and runs on the Nuclear Data ND6620 computer under the MIDAS operating system.

Inputs

Magtape	data files in NIAGARA format
Keyboard	logical unit (LU) 5, input in ASCII separated by blanks or commas.

Outputs

Diskfile	LU12, header and condensed spectra in format for input to program KFILTR
Lineprinter	LU6, header and condensed spectra in ASCII format. For diagnostic purposes, not normally printed out, sample output in Appendix A.

Subroutines Called

FREEFM	free field input routine (FORTRAN listing in Appendix B)
MCLI	utility to allow call of MIDAS system command from program (see Appendix C). Used to define LU12 as desired diskfile.
OANDC	utility to open diskfile on LU12 (see Appendix C)
DATIN	reads in data from the tapes (FORTRAN listing in Appendix B)
MTAPEF	tape input utility (see Appendix C)

BTIME	utility to return day and date in integer format (see Appendix C)
DATOUT	outputs data to LU12 (FORTRAN listing in Appendix B)

Input Variables

Record 1

NFSKIP	number of files on tape to skip before beginning processing
NRSKIP	number of records on tape to skip before beginning processing
NREC1	ID of first data record to process
NREC2	ID of last data record to process

Record 2a,...

NDREC(I)	up to 16 bad records to delete, entered on one or more lines, separated by commas, terminated by double carriage return

Record 3

MS	starting channel in input spectrum
MF	final channel in input spectrum
NCH	number of channels in condensed output spectrum. Eacn channel in the output spectrum will contain N input channels starting with MS and ending with MF, where N = (MS - MF + NCH)/NCH.

Record 4

FILE.ELEMENT	filename for output on LU12

Record 5

IANS	ASCII 'YES' or 'NO' in answer to whether to printout results on LU6

Output Variables

Header

HEADER(I)	header record
NREC1, NREC2	first and last output record
NTIME	total time spanned by data (seconds)
NCH	number of channels in output spectrum
MS,ME	starting and final channels in input spectrum

Data Records

NREC	record ID number
NID	MODE switch
I1(I)	output spectrum for Pod 1
I2(I)	output spectrum for Pod 2

470	16	[illegible]	0.614	-5.50	1.40	2.05	-3.83	2.23	-2.20
471	16	[illegible]	-1.11	-0.274	-1.52	1.75	-4.08	2.74	-1.69
472	16	0.475	[illegible]	-7.03	-5.30	5.738E-02	-1.66	1.65	-1.32
473	16	[illegible]	[illegible]E-02	3.36	-4.45	-1.06	-0.564	1.40	-1.81
474	16	[illegible]	1.36	-1.37	-2.84	-0.608	-0.351	4.850E-02	-2.04
475	16	[illegible]	-0.229	0.116	1.15	-1.15	-0.893	-0.807	0.399
476	16	-1.25	-0.504	-5.25	5.422E-02	-2.39	-1.07	0.403	0.757
477	16	-2.39	1.05	-6.85	3.18	-1.40	-1.54	0.503	0.814
478	16	-2.63	7.754E-02	-7.21	4.33	-1.40	-1.46	-1.46	2.33
479	16	-0.910	-0.439	-3.44	0.128	-0.792	-2.02	0.824	1.72
480	16	[illegible]	-0.731	6.658E-02	-1.99	0.700	-1.49	-4.587E-02	-1.026E-02
481	14	1.33	-0.360	-4.79	-1.44	0.880	-2.66	0.327	0.710
482	14	0.617	-0.331	1.28	-3.01	0.551	-0.926	-6.341E-02	0.789
483	14	0.663	0.309	0.476	-3.66	2.44	-1.33	0.632	-0.580
484	14	-1.36	1.39	2.27	1.13	4.28	-1.38	2.92	-2.07
485	17	1.86	-1.17	5.98	0.289	0.172	2.30	10.6	-1.12
486	17	1.34	-0.276	7.07	-1.99	-1.46	4.59	16.2	0.470
487	17	-0.371	1.06	11.9	0.137	-3.73	7.40	22.3	0.257
488	17	-1.84	2.25	17.0	0.704	-8.60	7.46	38.7	1.78
489	17	-1.75	1.22	22.1	1.93	-12.6	10.8	43.9	2.90
490	17	-1.70	2.65	19.9	-0.574	-8.44	7.54	46.8	3.42
491	17	0.410	0.945	19.8	-2.59	-3.58	5.49	38.8	1.89
492	17	0.371	1.36	28.5	-0.975	-12.8	11.6	51.5	4.07
493	17	0.280	0.448	27.0	0.308	-9.23	9.67	47.4	2.46
494	17	2.29	-1.43	17.2	-0.484	-6.03	4.86	48.3	3.42
495	17	4.076E-02	0.136	17.7	0.558	-4.05	4.44	40.3	1.89
496	17	9.328E-02	0.968	17.0	0.137	-5.12	3.24	51.8	1.73
497	17	0.443	1.79	12.3	0.141	-6.49	4.88	50.3	3.33
498	17	-1.91	2.68	26.2	2.33	-4.19	2.28	48.9	2.18
499	17	1.80	-1.17	3.62	1.34	-1.51	7.49	5.37	-0.562
500	17	0.357	-1.13	7.78	2.35	-1.23	2.88	14.6	-1.28
501	14	-0.550	0.853	0.769	3.20	1.08	-2.08	26.0	-3.63
502	14	-4.91	4.10	-3.93	6.39	0.433	-1.10	12.5	-1.74
503	14	-0.864	-0.240	6.57	2.67	-4.84	4.47	1.53	1.30
504	14	1.07	-0.314	-3.30	-0.459	1.03	-2.16	7.10	-1.24
505	14	3.839E-02	0.136	-4.19	0.909	-2.64	3.75	0.405	0.531
506	14	1.32	-1.41	-4.22	-0.666	1.31	-1.87	4.20	0.173
507	14	-0.673	4.225E-02	0.611	1.22	2.60	-5.29	10.5	-3.11
508	14	2.06	-1.49	-2.50	-1.25	0.465	-2.70	2.32	1.49
509	14	1.96	-2.13	-5.92	-0.575	-0.745	-0.987	2.64	1.76
510	18	0.817	-0.551	3.95	2.10	-1.20	0.889	2.56	1.14
511	18	-0.913	1.58	-2.55	0.785	-1.42	0.340	4.83	1.63
512	18	-0.741	2.20	-2.31	0.506	-1.05	-1.49	25.1	0.646
513	18	-2.10	3.64	-6.92	0.513	-3.52	4.56	15.5	1.34
514	18	-0.208	1.88	10.3	-0.623	-6.37	5.53	38.5	2.32
515	18	1.59	1.70	15.0	0.249	-10.1	8.90	57.5	2.65
516	18	0.522	0.388	24.6	3.26	-3.44	6.05	46.3	3.36
517	18	0.864	0.740	20.1	-0.983	-5.30	5.71	53.3	2.10
518	18	0.813	-1.35	13.9	2.91	-4.50	7.20	23.9	1.79
519	18	-0.344	1.11	3.28	1.133E-02	-5.17	4.64	21.2	0.829
520	18	-3.16	1.53	9.93	2.59	-2.12	0.648	8.76	0.189
521	18	-1.64	0.332	2.71	1.24	0.167	-0.534	0.260	-1.61
524	1	0.276	-0.341	-3.36	0.844	1.07	-0.466	-2.61	0.839
525	1	-0.958	0.246	5.27	-1.85	2.35	-2.20	-2.98	0.543

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REC.	MODE	B11161	RA26P1	CO60P1	TH32P1	B12161	RA26P2	CO60P2	TH32P2
420	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
421	1	-0.975	0.975	0.975	-0.975	-0.975	0.975	0.975	0.975
422	1	-1.33	1.26	-1.27	0.844	-1.36	1.18	1.16	-0.881
423	1	-1.39	1.51	-0.338	-0.466	1.13	-1.02	-1.42	-1.63
424	1	-0.630	0.790	1.66	-0.321	0.694	-0.782	-1.39	-1.03
425	1	1.51	-1.24	-1.13	0.665	0.539	-0.565	-0.447	-1.04
426	1	-0.900	0.100	0.734	0.673	-0.771	0.379	0.459	1.34
427	1	-0.465	0.413	-0.789	0.825	-0.669	1.15	-0.269	-0.240
428	1	0.265	-0.197	0.706	0.306	-0.746	1.41	1.37	-1.73
429	1	1.63	-1.63	-0.695	1.02	-0.607	0.673	1.92	-0.883
430	1	0.472	-0.240	-9.315E-02	-0.170	0.798	-0.597	-1.92	-1.59
431	1	-0.616	0.815	1.32	0.332	-0.169	0.218	-2.00	1.61
432	1	0.325	-0.864	0.220	0.989	0.752	0.276	-0.206	-1.28
433	1	1.45	-1.01	1.32	-1.60	0.774	-0.237	-1.30	-1.39
434	15	0.222	-0.377	-0.402	-1.91	-0.451	-0.938	0.793	0.601
435	15	-2.28	1.73	-2.41	2.68	1.65	-2.45	0.375	-4.549E-02
436	15	-1.44	0.869	-2.27	1.55	1.54	-1.94	1.24	-1.15
437	15	-1.57	0.897	-2.10	5.61	-0.690	-1.30	3.63	0.496
438	15	0.463	-1.303E-02	-2.39	-1.48	-0.631	-0.887	3.49	-1.07
439	15	1.07	-0.562	-1.54	-1.65	0.544	-1.59	3.59	-1.40
440	15	-1.12	1.11	-4.07	0.719	2.04	-1.14	0.638	-2.26
441	15	-0.369	-0.952	-2.12	1.42	-0.294	-1.05	-0.745	-1.80
442	15	-1.44	0.293	-5.28	1.89	0.258	-2.01	-1.72	-0.882
443	15	0.392	-2.12	-0.864	0.999	1.31	-2.58	0.512	-1.83
444	15	-3.52	1.38	-4.54	3.66	-1.33	-0.878	1.12	6.875E-02
445	15	-4.00	2.41	-0.997	2.10	1.11	-2.40	1.84	-0.858
446	15	-1.02	0.344	-5.48	1.14	1.68	-2.63	0.670	-0.387
447	15	1.56	-1.21	-2.05	0.145	3.25	-2.67	-1.15	-0.278
448	15	-0.721	-8.084E-02	-2.35	2.06	-0.434	-1.99	0.200	0.243
449	15	-3.70	2.09	-5.95	5.61	-0.350	-1.03	-0.777	-1.00
450	15	0.166	-0.588	-8.56	-1.87	1.54	-1.70	-1.23	-1.75
451	15	0.577	-5.295E-02	-12.0	0.803	-0.396	-0.519	-0.749	-4.165E-03
452	15	-1.48	-0.643	-0.467	5.28	-1.06	0.444	-0.679	-0.747
453	15	0.621	-1.38	-2.44	5.558E-03	0.978	-1.97	-1.41	-0.806
454	15	1.58	-3.65	0.799	0.336	-0.549	-1.55	0.530	-0.602
455	15	2.40	-3.49	0.507	-2.81	-2.42	-0.902	-0.607	0.389
456	15	-1.92	-0.170	-2.00	2.63	-2.263E-02	-1.62	-1.61	-1.08
457	15	-1.64	0.195	-0.730	0.695	-0.125	-2.49	0.522	-6.996E-02
458	15	-1.43	0.409	-7.00	0.389	0.129	-2.36	0.737	0.351
459	15	-0.851	-0.764	-4.36	0.670	0.439	-4.08	0.614	-0.191
460	15	-1.53	0.619	-5.86	1.80	-0.933	-2.19	1.09	-0.792
461	15	-2.67	1.95	-6.75	-0.692	1.43	-3.92	1.18	-1.09
462	14	-2.36	1.25	-2.79	-0.346	0.630	-3.37	1.16	0.264
463	14	-1.28	7.264E-02	-3.11	-1.32	1.34	-3.05	-0.236	-1.27
464	14	1.15	-2.46	-1.61	-3.06	3.40	-3.39	0.251	-1.84
465	14	-1.02	-2.16	8.69	-2.36	2.94	-3.35	0.541	-2.63
466	14	-1.49	-0.488	3.89	-1.66	0.220	-2.00	-2.937E-02	-1.30
467	14	1.40	-2.39	-3.49	-1.86	1.83	-4.22	0.529	-0.352
468	14	-3.253E-02	-1.15	-5.52	0.558	0.825	-2.15	1.10	-0.398
469	14	-4.61	1.34	2.97	4.85	1.42	-3.09	0.947	-1.57

517	18	1.95	1.31	0.990	0.159	4.836E-02*	-1.207E-03	0.789	0.417	* 0.361	* 1.515E-02*
518	18	4.47*	14.11*	0.988	3.872E-04	3.301E-02*	1.159E-02*	0.814	0.498	* 0.163	* 1.265E-02
519	18	2.16	6.57*	0.939	0.187	6.634E-03*	2.062E-03	0.793	0.370	* 0.145	* 4.737E-03
520	18	2.00	9.24*	0.820	0.219	2.309E-02*	1.053E-02*	0.888	0.143	6.030E-02*	-5.105E-04
521	18	-0.05	4.90*	0.884	0.166	5.204E-03*	6.089E-03	0.958	7.876E-02	2.786E-03	-1.523E-02
523	0										
524	1	-0.32	1.96	0.965	7.684E-02	-9.807E-03	4.797E-03	0.986	8.242E-02	-1.665E-02	4.814E-03
525	1	2.09	-0.63	0.913	0.121	1.155E-02*	-4.055E-03	1.03	*-1.147E-02	-1.911E-02	2.309E-03
526	1	-0.66	1.13	0.956	4.149E-02	1.993E-02*	-3.064E-03	0.971	2.112E-03	1.503E-02*	2.711E-03
527	1	1.41	2.13	0.936	4.944E-02	1.916E-02*	2.507E-03	0.921	0.187	-2.024E-02	7.283E-03
528	1	0.03	2.61	0.975	5.499E-02	-2.671E-03	8.822E-04	1.03	* 2.712E-02	-2.004E-02	-7.846E-03
529	1	0.36	0.49	0.998	9.256E-03	9.134E-03*	6.139E-04	1.01	3.490E-02	-7.749E-03	-1.555E-02
530	1	0.23	0.32	0.973	3.761E-02	1.588E-03	-1.228E-03	0.949	9.710E-02	-1.196E-02	4.859E-03
531	1	1.90	0.59	0.976	9.286E-02	-1.734E-02	8.246E-03	0.922	0.108	3.493E-03	7.604E-03
532	1	2.65	0.58	0.909	0.171	-1.247E-02	5.485E-03	0.860	0.247	*-1.706E-03	1.309E-02
533	1	0.47	0.83	0.926	7.387E-02	5.227E-03*	4.626E-03	0.925	0.103	-1.489E-02	1.824E-02*
534	1	1.27	1.07	0.964	0.109	-9.193E-03	1.866E-04	0.854	0.115	-5.713E-04	2.967E-02*
535	1	-0.04	3.13*	0.990	7.670E-02	-1.357E-02	-5.938E-03	0.922	0.192	1.222E-03	3.185E-03
536	1	1.09	0.78	1.05	*-2.810E-02	-1.462E-02	-2.537E-03	0.882	0.224	* 9.857E-03	7.452E-03
537	1	1.12	1.50	1.05	*-4.967E-02	-1.209E-02	-5.981E-03	1.04	*-0.128	1.495E-02*	5.868E-03
538	1	0.28	2.73	1.12	*-0.140	-3.092E-05	-8.184E-03	1.01	-7.739E-02	5.097E-03	4.372E-03
539	1	1.03	1.94	1.10	*-0.178	-7.146E-03	-2.129E-03	0.941	6.558E-02	1.022E-02	-7.512E-03
540	1	1.35	1.47	0.936	9.739E-02	5.459E-03*	3.267E-03	0.998	2.919E-02	-5.289E-03	-6.570E-03
541	1	0.21	-0.12	0.925	9.013E-02	4.092E-03*	1.429E-03	1.05	* 6.150E-03	-1.265E-02	-1.147E-02
542	1	2.22	0.41	0.951	2.936E-02	1.502E-02*	-1.519E-03	0.996	6.057E-02	7.717E-03	-1.678E-02
543	1	3.16*	2.04	0.872	0.210	-1.158E-02	4.279E-03	0.945	0.113	-1.148E-02	3.591E-03
544	1	-0.08	2.85	1.01	-1.746E-02	-7.434E-03	2.173E-03	1.01	-9.607E-02	2.130E-02*	3.519E-03
545	1	0.33	0.79	0.985	-1.747E-02	-8.463E-03	3.591E-03	1.01	-7.877E-02	7.970E-03	4.725E-03
546	1	1.96	0.46	1.00	-1.293E-02	2.607E-03	-4.242E-03	1.01	-0.140	1.814E-02*	4.314E-03
547	1	0.43	-0.35	0.985	1.007E-03	1.270E-03	1.520E-05	0.960	-4.113E-02	1.948E-02*	1.273E-02
548	1	0.49	1.59	1.04	*-6.040E-02	9.866E-03*	-4.892E-03	0.905	0.109	-4.764E-03	1.495E-02*
549	1	1.10	-0.44	0.928	0.118	1.711E-02*	-6.050E-03	0.938	5.988E-02	-1.407E-02	1.497E-02*
550	1	1.30	2.22	0.877	0.230	1.796E-03	-3.510E-03	0.963	0.145	-4.897E-03	-5.369E-03
551	1	2.01	0.01	1.01	2.970E-02	2.196E-03	-7.394E-03	0.995	3.449E-02	1.235E-02	-7.743E-03
552	1	3.40*	0.27	0.962	0.151	-1.536E-02	-2.998E-03	0.985	4.767E-02	9.929E-03	-1.153E-02
553	1	0.50	1.26	0.995	5.525E-02	-5.850E-03	-3.107E-03	0.975	2.795E-02	3.008E-02*	-1.031E-02
554	1	1.31	1.40	0.992	2.972E-02	1.921E-03	-1.940E-03	0.968	-2.662E-03	3.329E-02*	-6.568E-03
555	1	-0.57	-0.61	1.04	*-6.450E-02	-1.539E-03	-1.187E-03	0.995	-1.691E-02	1.377E-02	2.109E-03
556	1	0.38	0.51	1.98	*-0.111	2.804E-03	-5.822E-03	1.00	4.395E-03	-5.793E-03	-4.846E-03
557	1	2.21	1.12	0.908	0.103	1.634E-02*	-3.619E-03	0.969	7.047E-02	2.625E-03	-7.834E-03
558	1	2.04	-0.33	0.936	1.925E-03	1.481E-02*	3.279E-03	1.04	* 3.097E-03	-5.910E-03	-1.017E-02
559	1	0.80	0.48	0.974	-1.324E-02	2.817E-03	3.575E-03	0.989	7.929E-02	-6.260E-03	-2.387E-03
560	1	-0.41	1.31	0.953	6.535E-02	-1.638E-03	3.795E-03	0.965	7.121E-02	-4.862E-03	2.555E-03

463	14	-0.19	1.78	0.899	0.108	-9.197E-03	-2.298E-03	0.995	-5.750E-02	-5.730E-04	-1.243E-02
464	14	1.07	1.36	1.00	-8.417E-02	-5.467E-03	-8.019E-03	1.06	*-7.588E-02	2.726E-03	-1.714E-02
465	14	2.81	1.63	0.910	-6.140E-02	2.002E-02*	-5.729E-03	1.04	*-7.409E-02	4.687E-03	-2.352E-02
466	14	2.66	0.76	0.890	6.569E-02	8.147E-03*	-3.414E-03	0.960	-9.828E-04	8.263E-04	-1.274E-02
467	14	0.57	1.16	1.01	-0.117	-1.012E-02	-4.074E-03	1.01	-0.121	4.603E-03	-4.939E-03
468	14	1.14	0.80	0.949	1.523E-02	-1.515E-02	3.860E-03	0.979	-8.889E-03	8.461E-03	-5.316E-03
469	14	4.47*	1.44	0.758	0.205	5.857E-03*	1.795E-02*	0.997	-6.008E-02	7.434E-03	-1.490E-02
470	16	1.56	0.83	0.884	0.149	-1.511E-02	6.611E-03	1.02	*-9.976E-02	1.612E-02*	-2.004E-02
471	16	1.65	1.07	0.922	1.856E-02	-2.071E-03	-3.393E-03	1.01	-0.114	1.959E-02*	-1.591E-02
472	16	1.55	1.48	0.973	-4.957E-03	-1.888E-02	-1.507E-02	0.955	1.795E-02	1.221E-02	-1.452E-02
473	16	4.25*	1.57	0.924	9.535E-02	6.585E-03*	-1.269E-02	0.920	7.713E-02	1.052E-02	-1.686E-02
474	16	2.22	1.52	0.814	0.251	-4.893E-03	-7.299E-03	0.935	8.869E-02	1.353E-03	-1.878E-02
475	16	2.81	0.44	0.832	8.534E-02	-1.205E-03	5.810E-03	0.918	5.930E-02	-4.433E-03	1.217E-03
476	16	1.01	1.41	0.901	6.448E-02	-1.448E-02	2.203E-03	0.879	4.954E-02	3.752E-03	4.148E-03
477	16	1.33	-0.22	0.827	0.183	-1.846E-02	1.246E-02*	0.910	2.420E-02	4.426E-03	4.617E-03
478	16	0.18	0.29	0.842	0.109	-1.934E-02	1.627E-02*	0.910	2.843E-02	-8.864E-03	1.705E-02*
479	16	0.47	-0.37	0.915	6.942E-02	-9.999E-03	2.447E-03	0.929	-1.921E-03	6.600E-03	1.204E-02*
480	16	2.79	1.31	0.987	4.723E-02	-1.321E-03	-4.501E-03	0.975	2.667E-02	7.147E-04	-2.139E-03
481	14	-0.19	0.90	1.02	2.981E-02	-1.334E-02	-2.697E-03	0.981	-3.668E-02	3.237E-03	3.759E-03
482	14	-0.51	1.87	0.979	7.303E-02	1.670E-03	-7.881E-03	0.970	5.749E-02	5.961E-04	4.409E-03
483	14	0.22	2.08	0.981	0.126	-3.119E-04	-9.994E-03	1.03	* 3.540E-02	5.298E-03	-6.804E-03
484	14	0.84	3.59*	0.896	0.209	4.130E-03*	5.754E-03	1.09	* 3.309E-02	2.081E-02*	-1.900E-02
485	17	2.73	6.63*	1.03	1.356E-02	1.332E-02*	2.973E-03	0.959	0.232	* 7.265E-02*	-1.122E-02
486	17	0.40	4.95*	1.01	8.178E-02	1.600E-02*	-4.525E-03	0.908	0.357	* 0.111	* 1.796E-03
487	17	0.77	3.36*	0.912	0.183	2.798E-02*	2.475E-03	0.838	0.509	* 0.152	* 5.039E-05
488	17	4.32*	4.19*	0.875	0.274	* 4.047E-02*	4.337E-03	0.687	0.512	* 0.263	* 1.249E-02
489	17	0.55	2.65	0.879	0.196	5.322E-02*	8.369E-03	0.562	0.691	* 0.298	* 2.169E-02*
490	17	1.90	3.38*	0.881	0.304	* 4.785E-02*	1.391E-04	0.692	0.517	* 0.318	* 2.599E-02*
491	17	1.26	0.55	0.970	0.175	4.757E-02*	-6.502E-03	0.843	0.406	* 0.264	* 1.340E-02
492	17	3.62*	4.20*	0.969	0.206	6.915E-02*	-1.178E-03	0.557	0.734	* 0.349	* 3.128E-02*
493	17	1.03	1.08	0.965	0.137	6.546E-02*	3.036E-03	0.668	0.632	* 0.322	* 1.614E-02*
494	17	2.05	1.69	1.05	*-5.942E-03	4.098E-02*	4.335E-04	0.767	0.371	* 0.328	* 2.596E-02*
495	17	1.85	3.10*	0.955	0.113	4.234E-02*	3.860E-03	0.828	0.348	* 0.274	* 1.346E-02
496	17	1.58	2.88	0.957	0.176	4.061E-02*	2.475E-03	0.795	0.283	* 0.352	* 1.212E-02
497	17	1.31	1.23	0.972	0.239	2.900E-02*	2.488E-03	0.752	0.373	* 0.341	* 2.520E-02*
498	17	1.22	1.68	0.872	0.306	* 6.337E-02*	9.689E-03*	0.824	0.231	* 0.331	* 1.577E-02*
499	17	6.07*	19.21*	1.03	1.374E-02	7.468E-03*	6.418E-03	0.907	0.514	* 3.732E-02*	-6.660E-03
500	17	0.64	2.37	0.968	1.681E-02	1.777E-02*	9.736E-03*	0.915	0.264	* 9.946E-02*	-1.258E-02
501	14	0.72	2.43	0.930	0.168	4.111E-04	1.254E-02*	0.987	-5.127E-03	0.177	*-3.181E-02
502	14	3.66*	6.23*	0.746	0.414	*-1.123E-02	2.299E-02*	0.967	4.819E-02	8.539E-02*	-1.630E-02
503	14	0.77	5.53*	0.917	8.450E-02	1.478E-02*	1.081E-02*	0.804	0.350	* 1.138E-02	8.603E-03
504	14	0.92	1.76	0.998	7.894E-02	-9.665E-03	5.158E-04	0.985	-9.224E-03	4.904E-02*	-1.225E-02
505	14	-0.08	2.16	0.955	0.113	-1.187E-02	4.682E-03	0.872	0.311	* 3.766E-03	2.292E-03
506	14	-0.38	1.79	1.03	-4.497E-03	-1.194E-02	-1.628E-04	1.01	6.582E-03	2.944E-02*	-6.356E-04
507	14	1.02	3.17*	0.925	0.106	2.217E-05	6.027E-03	1.03	*-0.179	7.202E-02*	-2.755E-02
508	14	1.06	2.80	1.04	*-1.025E-02	-7.690E-03	-2.069E-03	0.968	-3.871E-02	1.672E-02*	1.012E-02
509	14	-0.37	0.00	1.04	-5.931E-02	-1.615E-02	1.361E-04	0.930	5.961E-02	1.890E-02*	1.233E-02
510	18	3.76*	-0.23	0.988	6.089E-02	8.297E-03*	8.935E-03*	0.916	0.156	1.831E-02*	7.249E-03
511	18	1.55	0.15	0.915	0.223	-7.801E-03	4.604E-03	0.909	0.126	3.370E-02*	1.131E-02
512	18	-0.11	10.04*	0.922	0.270	*-7.209E-03	3.686E-03	0.921	2.697E-02	0.171	* 3.239E-03
513	18	-1.40	3.84*	0.865	0.379	*-1.861E-02	3.712E-03	0.845	0.355	* 0.106	* 8.940E-03
514	18	4.75*	10.41*	0.944	0.245	2.394E-02*	-2.219E-05	0.756	0.407	* 0.261	* 1.696E-02*
515	18	5.31*	8.50*	1.02	0.232	3.566E-02*	2.844E-03	0.640	0.590	* 0.390	* 1.966E-02*
516	18	2.21	2.44	0.975	0.132	5.939E-02*	1.275E-02*	0.847	0.436	* 0.314	* 2.544E-02*

J0:61.10   PROCESSED ON 14 JAN 1985 11:46:55 AM

OUTPUT FOR KALMAN FILTER
USING DATA FROM CHANNEL 19 TO 242
CONDENSED TO 16 OUTPUT VECTOR CHANNELS
THRESHOLD IS   3.00
FINAL LEARNING RECORDS, 9999 FOR POD 1, 9999 FOR POD 2
INPUT VECTOR FOR POD1 HAS 4 VARIABLE INTENSITIES, LEAVING 12 DEGREES OF FREEDOM
INPUT VECTOR FOR POD2 HAS 4 VARIABLE INTENSITIES, LEAVING 12 DEGREES OF FREEDOM

REC.	MODE	XS01	XS02	B11161	RA26P1	CO60P1	TH32P1	B12161	RA26P2	CO60P2	TH32P2
420	1	1.09	-1.54	0.974	4.844E-02	-2.277E-03	3.755E-03	0.962	4.209E-02	4.235E-03	5.512E-03
421	1	1.65	2.73	0.963	8.352E-02	-9.009E-04	-5.634E-03	0.955	0.119	6.165E-03	6.656E-03
422	1	3.44*	1.55	0.923	0.138	-4.660E-03	5.202E-03	0.879	0.196	7.858E-03	5.279E-03
423	1	1.77	2.29	0.685	0.254	-3.290E-03	-1.604E-03	1.00	2.607E-02	1.323E-03	-2.639E-03
424	1	0.62	1.23	0.907	0.213	2.685E-03	-1.187E-03	0.987	2.929E-02	-9.528E-04	-1.769E-03
425	1	1.77	0.73	1.01	2.026E-02	-5.491E-03	3.048E-03	0.984	3.786E-02	1.911E-03	-3.007E-03
426	1	0.91	2.45	0.903	0.137	2.449E-05	3.469E-03	0.927	9.904E-02	4.796E-03	8.939E-03
427	1	0.19	0.95	0.915	0.165	-4.384E-03	4.426E-03	0.928	0.159	2.686E-03	1.366E-03
428	1	-1.56	2.45	0.945	0.119	-2.319E-04	2.724E-03	0.921	0.200	7.960E-03	-8.820E-03
429	1	0.20	1.78	1.02	-2.032E-02	-3.990E-03	5.530E-03	0.924	0.155	1.262E-02	-4.717E-03
430	1	1.40	2.02	0.968	9.241E-02	-2.518E-03	1.617E-03	0.976	6.797E-02	-6.066E-03	-1.131E-02
431	1	1.53	2.38	0.920	0.181	1.373E-03	3.230E-03	0.943	0.120	-1.144E-02	1.203E-02
432	1	1.97	1.47	0.959	4.585E-02	-1.328E-03	5.503E-03	0.974	0.125	6.529E-04	-1.063E-02
433	1	2.60	1.00	1.01	2.612E-02	1.765E-03	-3.226E-03	0.977	9.486E-02	-7.786E-03	-1.344E-02
434	15	1.06	0.56	0.963	7.411E-02	-2.485E-03	-4.238E-03	0.939	5.684E-02	6.386E-03	2.869E-03
435	15	4.20*	-0.74	0.857	0.234	-7.465E-03	1.083E-02*	1.00	-2.489E-02	3.559E-03	-2.428E-03
436	15	-1.30	1.67	0.893	0.169	-7.099E-03	7.132E-03	1.00	2.273E-03	9.381E-03	-1.144E-02
437	15	0.97	1.85	0.887	0.171	-6.694E-03	2.047E-02*	0.932	3.723E-02	2.558E-02*	2.009E-03
438	15	1.80	2.20	0.973	0.102	-7.414E-03	-2.823E-03	0.934	5.960E-02	2.464E-02*	-1.084E-02
439	15	0.06	1.44	0.998	6.008E-02	-5.314E-03	-3.403E-03	0.970	2.157E-02	2.532E-02*	-1.349E-02
440	15	0.70	1.77	0.906	0.187	-1.157E-02	4.389E-03	1.02	* 4.577E-02	5.343E-03	-2.058E-02
441	15	1.39	3.88*	0.938	3.043E-02	-6.729E-03	6.701E-03	0.944	5.070E-02	-4.017E-03	-1.680E-02
442	15	-0.30	-0.64	0.892	0.125	-1.457E-02	8.236E-03	0.961	-1.339E-03	-1.063E-02	-9.283E-03
443	15	1.23	1.88	0.970	-5.813E-02	-3.630E-03	5.309E-03	0.994	-3.228E-02	4.491E-03	-1.707E-02
444	15	2.69	1.08	0.804	0.246	-1.297E-02	1.407E-02*	0.912	6.011E-02	8.573E-03	-1.492E-03
445	15	0.33	0.38	0.784	0.286	*-3.958E-03	8.939E-03*	0.988	-2.248E-02	1.348E-02	-9.085E-03
446	15	2.29	-1.02	0.910	0.174	-1.505E-02	5.787E-03	1.01	-3.508E-02	5.554E-03	-5.227E-03
447	15	1.95	1.40	1.02	1.064E-02	-6.556E-03	2.502E-03	1.05	*-3.680E-02	-6.765E-03	-4.336E-03
448	15	2.51	4.32*	0.923	9.661E-02	-7.298E-03	8.782E-03*	0.940	-8.650E-05	2.375E-03	-6.073E-05
449	15	2.39	1.36	0.797	0.262	*-1.621E-02	2.045E-02*	0.942	5.206E-02	-4.231E-03	-1.029E-02
450	15	0.65	0.79	0.960	5.810E-02	-2.267E-02	-4.125E-03	1.00	1.545E-02	-7.285E-03	-1.637E-02
451	15	3.36*	2.23	0.978	9.873E-02	-3.119E-02	4.665E-03	0.941	7.956E-02	-4.038E-03	-2.089E-03
452	15	2.22	3.56*	0.891	5.393E-02	-2.647E-03	1.936E-02*	0.920	0.132	-3.566E-03	-8.177E-03
453	15	0.08	2.00	0.979	-1.911E-03	-7.542E-03	2.043E-03	0.984	1.086E-03	-8.533E-03	-8.658E-03
454	15	2.04	1.25	1.02	-0.174	4.872E-04	3.127E-03	0.936	2.369E-02	4.612E-03	-6.983E-03
455	15	0.70	2.22	1.05	*-0.162	-2.369E-04	-7.209E-03	0.879	5.883E-02	-3.078E-03	1.134E-03
456	15	2.32	1.68	0.872	8.982E-02	-6.445E-03	1.066E-02*	0.953	1.985E-02	-9.843E-03	-1.091E-02
457	15	0.34	2.12	0.884	0.118	-3.299E-03	4.308E-03	0.949	-2.717E-02	4.553E-03	-2.620E-03
458	15	0.55	-0.24	0.893	0.134	-1.881E-02	3.304E-03	0.957	-2.034E-02	6.012E-03	8.205E-04
459	15	0.94	1.20	0.917	4.470E-02	-1.227E-02	4.227E-03	0.967	-0.113	5.179E-03	-3.623E-03
460	15	2.18	1.28	0.889	0.150	-1.600E-02	7.955E-03	0.924	-1.103E-02	8.390E-03	-8.546E-03
461	15	2.51	1.59	0.840	0.251	-1.819E-02	-2.509E-04	0.997	-0.105	9.002E-03	-1.101E-02
462	14	-0.52	0.71	0.853	0.198	-8.406E-03	8.892E-04	0.973	-7.513E-02	8.891E-03	1.061E-04

```
  J0161.DD       PROCESSED ON 14 JAN 1985 11:46:27 AM
  RECORDS  420 TO  560   1410 SECS
STARTING CHANNEL=   19. FINAL CHANNEL=  242. CONDENSED TO 16 CHANNELS FOR FILTER
FINAL LEARNING RECORDS FOR INPUT VARIANCE
    9999 FOR POD 1, 9999 FOR POD 2


POD 1 LIBRARY

    1  PREGA.B11161,380,1.0

CONDENSED SPECTRUM     0.183E 04     653.         427.         222.         176.         116.         83.1         98.8
                         48.3        37.8         26.6         29.4         17.6         25.8         16.9         6.24

    2  DAT.RA26P1,1480,.04

CONDENSED SPECTRUM     0.106E 04     323.         268.         96.9         61.3         74.7         47.5         22.6
                         26.9        27.1         4.95         7.10         3.07        0.905        0.736        0.000

    3  DAT.CO60P1,380,.01

CONDENSED SPECTRUM     0.255E 04   0.118E 04      766.         633.         508.         577.         484.         75.2
                         2.24       0.737        0.421         1.66         1.84         1.84         1.16         1.18

    4  DAT.TH32P1,1000,.01

CONDENSED SPECTRUM     0.277E 04   0.194E 04   0.144E 04       875.         896.         230.         181.         195.
                         196.        115.         110.         152.         104.         152.         169.         1.13

GRANDSUMS:     0.381E 04    0.203E 04    0.679E 04    0.953E 04

POD 2 LIBRARY

    1  PREGA.B12161,380,1.0

CONDENSED SPECTRUM     0.213E 04     785.         527.         267.         223.         138.         101.         125.
                         61.0        49.3         29.4         34.2         22.6         27.2         26.6         8.37

    2  DAT.RA26P2,1480,.04

CONDENSED SPECTRUM     0.113E 04     375.         278.         98.7         63.4         74.9         48.0         24.9
                         25.1        28.8         5.15         7.14         3.19         1.05        0.736        0.000

    3  DAT.CO60P2,380,.01

CONDENSED SPECTRUM     0.275E 04   0.124E 04      781.         645.         523.         551.         503.         108.
                         2.29       0.658        0.211         1.95         1.84         1.79         1.18         1.05

    4  DAT.TH32P2,1000,.01

CONDENSED SPECTRUM     0.292E 04   0.196E 04   0.152E 04       889.         934.         236.         184.         192.
                         202.        117.         108.         153.         107.         139.         185.         1.24

GRANDSUMS     0.456E 04    0.216E 04    0.711E 04    0.985E 04

INITIAL  INPUT VECTORS
POD 1    0.949        0.379E-01    0.949E-02    0.949E-02
POD 2    0.948        0.379E-01    0.948E-02    0.948E-02
```

Appendix A: Sample Outputs for File J0161

1. Printer File — lineprinter output (LU6) from KFILTR
2. Disk File — normalized intensities (LU3) from KFILTR
3. Plot (Fig. A1) — plot of normalized intensity estimates

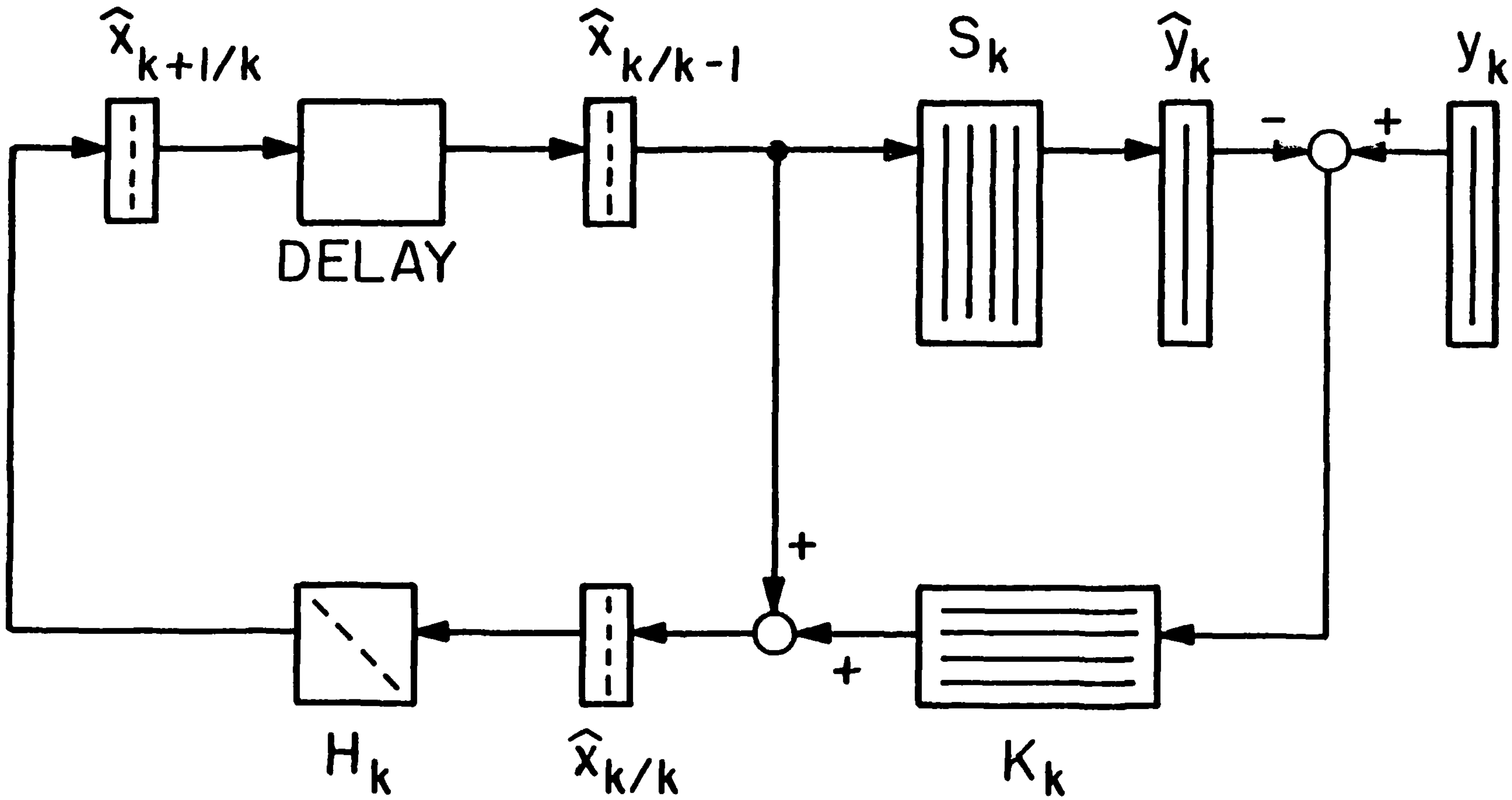

Figure 2 Diagram of the Kalman Filter for estimation of the source intensities x_k.

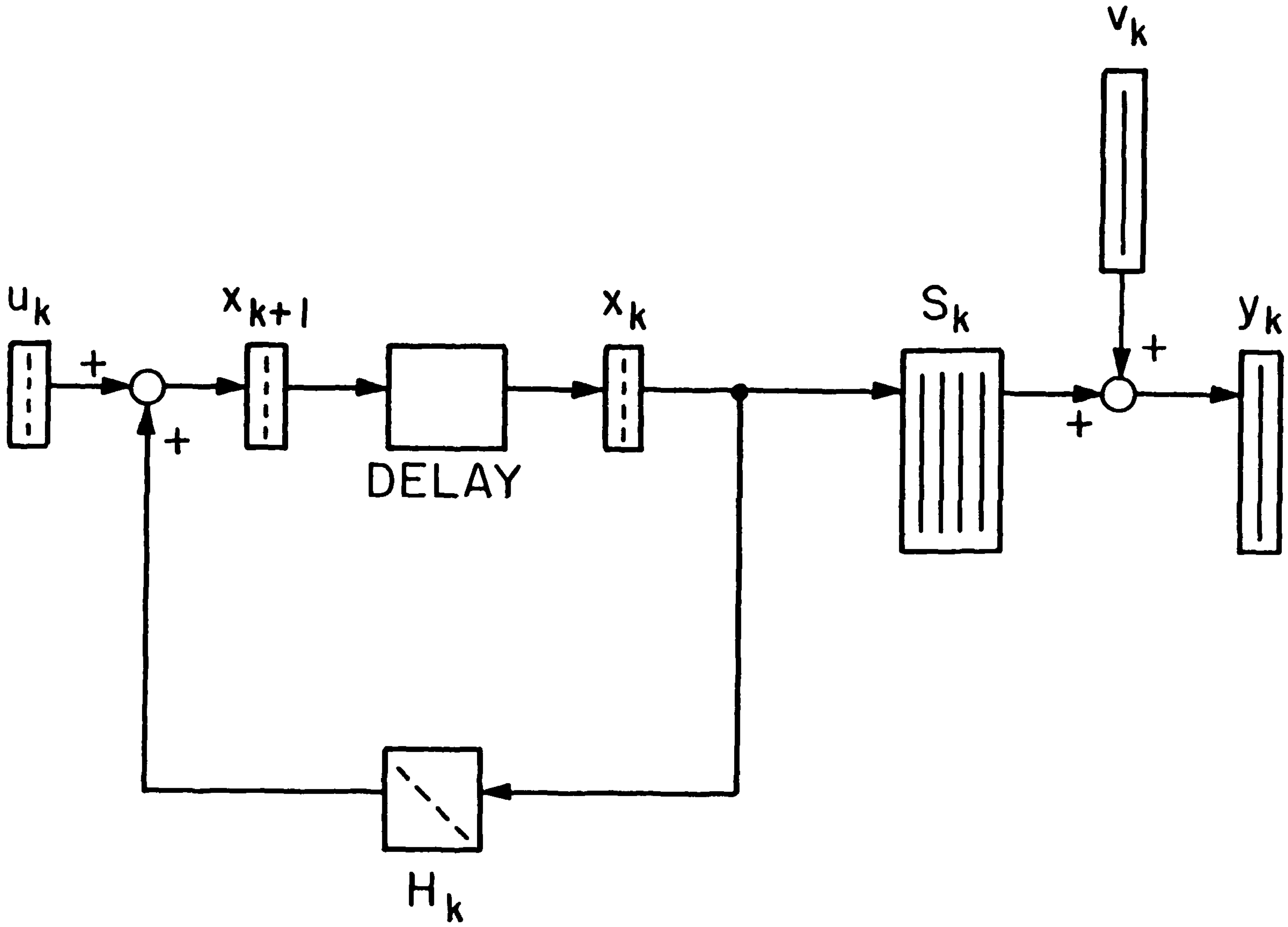

Figure 1 System model for the relationship between the source intensities x_k and the observed data y_k.

LIBIN inputs library spectra from logical unit LUF, number of channels M

Output from KOUT

Lineprinter LU6, lineprinter output, input information, header, and results

Disk File LU3, normalized intensities

Lineprinter Output Columns

REC record number

MODE data MODE switch

XSQ1, XSQ2 normalized chi-square (RSS) for pods 1 and 2

Library Elements relative intensities for pod 1 followed by pod 2.

Disk File Output Columns

REC, MODE same as above

Library Elements normalized intensities for pod 1 followed by pod 2.

References

1. G.W. Phillips and B.G. Glagola, "Program PAGSCN - Data Screen for the ND6620 Computer," NRL Memorandum Report 5269, March 1984.

2. G.W. Phillips and B.G. Glagola, "Program PREGA - Pivotal Regression Analysis of Gamma-Ray Spectra from NaI(Tl) Detectors for the ND6620 Computer, NRL Memorandum Report 5275, April 1984.

3. B.D.O Anderson and J.B. Moore, "Optimal Filtering," Prentice-Hall, Englewood Cliffs, N.J. (1979).

4. J.L. LeMay and W.L. Brogan, "Kalman Filtering, Short Course Notes," Continuing Education Institute, Columbia, MD (1982).

L	dimension of Q on call to DDKALM
IER	error indicator from DDKALM
I,J	DO loop indices

Input to KLIN

Keyboard	LU5, on initial call only, free field format separated by commas
Data File	LU12, contains output from KLPREP

Input Variables from Keyboard

<u>Record 1</u>

File.Element	file name for output of KLPREP
LREC1, LREC2	optional start/stop records, defaults from KLPREP
IQ1, IQ2	optional cutoff records k0 for calculation of Q, x_m, and s, pods 1 and 2

<u>Records 2a,...</u>

NDREC(I)	optional bad record numbers to delete during calculation

Input to KINIT

Keyboard	LU5, free field format separated by commas
Disk File	LU8, library spectra in Nuclear Data spectral format

Input Variables from Keyboard

<u>Records 3a, ...</u> library spectra for Pod 1, Pod 2

File.Element	filename for spectrum
REALX(1)	counting time for spectrum
REALX(2)	initial intensity, $x_0/-1$
REALX(3)	optional fractional error, $(q_o)^{1/2}$, default = 1.0

Subroutines Called by KINIT

FREEFM	free field input subroutine (listing in Appendix B)

Q(8)	input noise vector, diagonal elements of input noise matrix Q
V1(8,8), V2(8,8)	covariance matrices P for pods 1 and 2
Y1(16), Y2(16)	input data spectra for pods 1 and 2
R1(16), R2(16)	Poisson variances for pods 1 and 2
T1(16,16), T2(16,16)	work arrays for DDKALM
T3(16)	work vector for DDKALM
S1(16,8), S2(16,8)	library response matrices for pods 1 and 2
Q1(8), Q2(8)	vectors of input noise factor q_0 for pods 1 and 2
P1(8), P2(8)	vector of diagonal elements of covariance matrix P for pods 1 and 2
K	step index for Kalman filter, increments by one each for record
IN, IL, IS, IT	dimensions for arrays used in DDKALM
NR	record number
ICRT	logical unit number for CRT
LP	logical unit number for line printer
INIT	initially 0, set to 1 after call to KINIT
NID	MODE switch for input data
M	number of channels for condensed data
MS	starting channel for 256 channel spectra
MF	final channel for 256 channel spectra
N1, N2	number of library elements for pods 1 and 2
IDAY, IYR	Julian date, year
IHR, IMIN, ISEC	hour of day, minute, second

The cutoff record K1 is the minimum of K0, input by the operator, or the last record of the initial block of background (MODE = 1) data. There should be at least 30 records of MODE = 1 at the beginning of the data in order to get a good value for the sample mean x_m and standard deviation s.

The normalized intensities n(x) are output to a disk file on LU3. The intensities $\hat{x}_{k/k}$ are listed in the printout on LU6 and are flagged by an asterisk whenever n(x) or one of the three exponentially weighted averages exceeds its standard deviation by a factor THSIG currently set at 2.0 sigma. Sample outputs and plots of $\hat{x}_{k/k}$ are given for collection J0039 in Appendix A.

Language

The program is written in DEC RT11 FORTRAN and runs on the Nuclear Data ND6620 computer under the MIDAS operating system.

Inputs

Data input by KLIN. Library spectra input by KINIT.

Outputs

Data output by KOUT. Running status output to CRT (LU5).

Subroutines Called

KLIN	inputs data from disk file on LU12. (output of KLPREP). Listing in Appendix B.
KINIT	inputs library spectra from LU8, condenses to number of channels used for data from KLPREP. Listing in Appendix B.
BTIME	utility to return day and date in integer format (see Appendix C).
KSTEP	calculates the diagonal elements for the input noise matrix Q.
DDKALM	computes the updated estimates $x_{k/k}$ and $P_{k/k}$.
KOUT	outputs the results.

Variables

X1(8), X2(8)	vector of estimated source intensities x for pods 1 and 2
H(8)	source transition vector, diagonal elements of transition matrix H

PROGRAM KFILTR

Operation

This is the main Kalman Filter program. It calls subroutines KLIN to read in the data from the file prepared by KLPREP, KINIT to read in the library spectra and condense them to the same number of channels as the data, KSTEP to prepare for analyzing the next record, DDKALM to do the Kalman filter equations, and KOUT to output the results of each record. Sample output and plots are given in Appendix A for collection J0039.

The Kalman Filter subroutine DDKALM is a modification of a proprietary subroutine FTKALM, copywrited by International Mathematical and Statistical Library, Inc. (IMSL). It in turn calls a number of proprietary IMSL routines. Listings are given in Appendix D for illustrative purposes only.

The lineprinter output gives for each Pod the normalized chisquare or residual sum of squares (RSS)

$$(1/ND) \sum_{I} (S_k \hat{x}_{k/k-1} - y_k)^2 / y_k$$

for each record k with ND degrees of freedom and Poisson data y_k, where the sum is over the channels I in the data spectrum. If this exceeds a threshold THRESH currently set at 3.0 sigma, the value is flagged by an asterisk. Source intensities are given for each library member and for each pod. Exponentially weighted averages are calculated for each library source for three different slopes,

$$a = 0.95,\ 0.80,\ \text{and}\ 0.667.$$

A normalized intensity, n(x), is also calculated, by

$$n(x) = (\hat{x}_{k/k} - x_m)/s$$

where the sample mean x_m and standard deviation s are given for $k \leq k1$ by

$$x_m = \bar{x}_k$$

$$s = (v_k)^{1/2}$$

and for $K > K1$ by

$$x_m = \bar{x}_{k1}$$

$$s = (v_{k1})^{1/2}.$$

526	1	5.957E-02	-0.807	8.65	-1.55	0.570	-1.95	2.07	0.582
527	1	-0.396	-0.702	8.34	0.147	-1.05	1.47	-3.14	1.14
528	1	0.522	-0.629	-0.477	-0.348	2.48	-1.49	-3.11	-0.707
529	1	1.07	-1.23	4.29	-0.429	1.88	-1.34	-1.30	-1.65
530	1	0.472	-0.858	1.24	-0.990	-0.138	-0.196	-1.92	0.844
531	1	0.541	-0.130	-6.40	1.89	-0.398	1.277E-02	0.352	1.18
532	1	-1.05	0.902	-4.44	1.05	-3.01	2.58	-0.404	1.85
533	1	-0.637	-0.380	2.71	0.791	-0.901	-8.150E-02	-2.35	2.48
534	1	0.246	7.725E-02	-3.11	-0.559	-3.22	0.210	-0.236	3.87
535	1	0.884	-0.343	-4.88	-2.42	-1.00	1.56	2.913E-02	0.640
536	1	2.33	-1.72	-5.31	-1.39	-2.30	2.15	1.31	1.16
537	1	2.34	-2.01	-4.28	-2.44	2.76	-4.34	2.06	0.967
538	1	3.86	-3.20	0.590	-3.11	1.71	-3.41	0.602	0.785
539	1	3.42	-3.70	-2.28	-1.26	-0.408	-0.777	1.36	-0.666
540	1	-0.395	-7.063E-02	2.81	0.378	1.45	-1.45	-0.933	-0.551
541	1	-0.660	-0.166	2.26	-0.181	3.10	-1.87	-2.02	-1.15
542	1	-5.025E-02	-0.966	6.67	-1.08	1.38	-0.869	0.989	-1.80
543	1	-1.92	1.41	-4.07	0.686	-0.260	8.938E-02	-1.85	0.689
544	1	1.27	-1.58	-2.40	4.496E-02	1.95	-3.76	3.00	0.680
545	1	0.765	-1.58	-2.82	0.477	1.91	-3.44	1.03	0.828
546	1	1.12	-1.52	1.66	-1.91	1.86	-4.58	2.53	0.778
547	1	0.753	-1.34	1.12	-0.612	0.217	-2.75	2.73	1.80
548	1	2.07	-2.15	4.59	-2.10	-1.57	2.602E-02	-0.856	2.08
549	1	-0.588	0.206	7.52	-2.46	-0.505	-0.882	-2.23	2.08
550	1	-1.81	1.68	1.33	-1.68	0.322	0.682	-0.875	-0.405
551	1	1.24	-0.962	1.49	-2.87	1.34	-1.35	1.67	-0.694
552	1	0.213	0.635	-5.60	-1.53	1.04	-1.11	1.32	-1.16
553	1	0.996	-0.625	-1.76	-1.56	0.700	-1.47	4.30	-1.01
554	1	0.927	-0.962	1.38	-1.21	0.478	-2.04	4.77	-0.551
555	1	2.12	-2.47	-1.933E-02	-0.977	1.35	-2.30	1.88	0.508
556	1	3.03	-2.31	1.74	-2.39	1.59	-1.91	-1.01	-0.341
557	1	-1.08	8.386E-03	7.20	-1.72	0.493	-0.687	0.237	-0.712
558	1	-0.411	-1.33	6.53	0.382	2.80	-1.93	-1.03	-0.990
559	1	0.484	-1.53	1.74	0.472	1.14	-0.524	-1.08	-4.053E-02
560	1	4.075E-03	-0.493	-5.940E-02	0.539	0.364	-0.673	-0.870	0.564

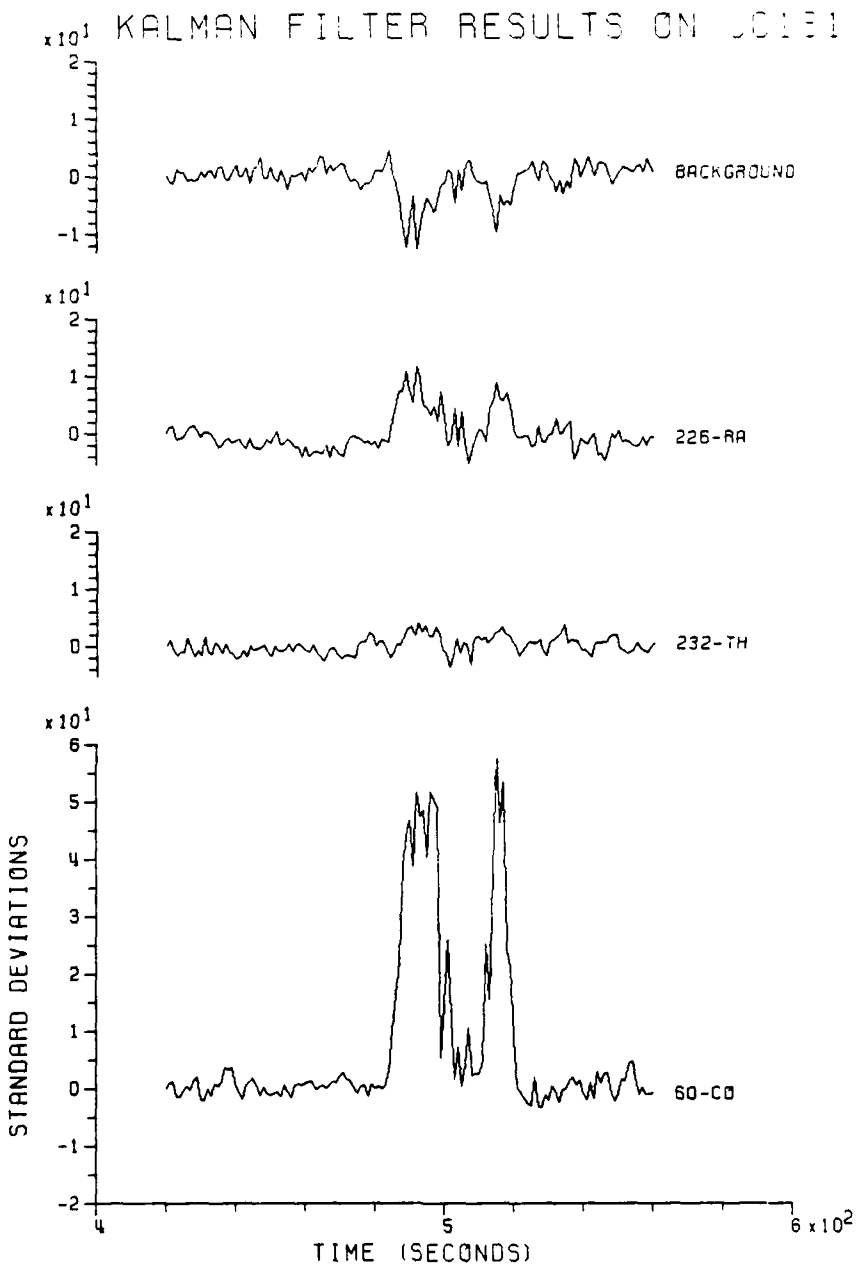

Figure A1 Plot of the normalized intensity estimates from the Kalman Filter for the data of J0161, containing a double peak due to ^{60}Co. The variation in the Background and ^{226}Ra intensities are likely the effect of small corrections to the model due to differences between the shape of the ^{60}Co library standard and the source spectrum.

Appendix B: FORTRAN Listings, DEC RT-11

1. KLPREP
2. FREEFM
3. DATIN
4. DATOUT
5. KFILTR
6. KLIN
7. KINIT
8. LIBIN
9. KSTEP
10. KOUT

```
      C      PROGRAM KLPREP
      C      READS NIAGARA DATA, CONDENSES, AND WRITES TO DATA
      C      FILE FOR USE BY KALMAN FILTER PROGRAM
      C      LAST MODIFIED BY G.W.PHILLIPS, APRIL 1982
      C
0001         INTEGER DATA(1024),HEADER(256),NDREC(16)
0002         EQUIVALENCE (DATA,HEADER)
0003         INTEGER YES,PERIOD,BLANK
0004         REAL*8 ALPHA,FILDEF(5)
0005         COMMON/ARRAY/DATA
0006         COMMON /DATA/IDAT(80)/FREE/INTEG(16),REALX(16),ALPHA(16)
0007         DATA FILDEF/8H@DEF 12 ,1H ,1H.,1H ,1H@/,ABLANK/8H        /
0008         DATA YES/1HY/,IOUT/5/,IN/5/,LP/5/,NXREC/-1/,NFILE/12/
0009         DATA NCH/16/,INCH/16/,MS/3/,MF/255/,PERIOD/1H./,BLANK/1H /
0010         DATA NDEL/0/,NFSKIP/0/,NRSKIP/0/,IBLK/2H  /
      C
0011   10    CONTINUE
0012         WRITE(IOUT,20)
0013   20    FORMAT(' ENTER # OF FILES TO SKIP,# OF RECORDS TO SKIP,'/
            1     4X,'FIRST RECORD,LAST RECORD'/)
0014         READ(IN,30) IDAT
0015      30 FORMAT(80A1)
0016         N=4
0017         M=1
0018         NA=1
0019         ITYPE=1
0020         CALL FREEFM(N,M,NA,ITYPE)       !PARSING SUBROUTINE
0021         IF(N.NE.4) GOTO 10
0023         IF(INTEG(1).NE.IBLK) NFSKIP=INTEG(1)
0025         IF(INTEG(2).NE.IBLK) NRSKIP=INTEG(2)
0027         NREC1=INTEG(3)
0028         NREC2=INTEG(4)
      C
0029         NDEL=0
0030         WRITE(IOUT,32)
0031  32     FORMAT(' ENTER UP TO 16 BAD RECORDS TO DELETE'/)
0032  33     READ(IN,34) L,IDAT
0033  34     FORMAT(Q,80A1)
0034         IF(L.LE.0) GOTO 40
0036         N=16-NDEL
0037         IF(N.LE.0) GOTO 40
0039         M=1
0040         NA=1
0041         ITYPE=1
0042         CALL FREEFM(N,M,NA,ITYPE)
0043         IF(N.LE.0) GOTO 40
0045         DO 35 I=1,N
0046  35     NDREC(NDEL+I)=INTEG(I)
0047         NDEL=NDEL+N
0048         GOTO 33
```

```
      C
0049  40    WRITE(IOUT,41)
0050  41    FORMAT(' ENTER STARTING, FINAL DATA CHANNELS'
          1     ' (,# OF OUTPUT CHANNELS FOR FILTER)'/)
0051        READ(IN,42)IDAT
0052  42    FORMAT(80A1)
0053        N=0
0054        M=1
0055        NA=1
0056        ITYPE=1
0057        CALL FREEFM(N,M,NA,ITYPE)
0058        IF(N.LT.2) GOTO 35
0060        MS=INTEG(1)
0061        MF=INTEG(2)
0062        IF(N.EQ.3) NCH=INTEG(3)
0064        IF(NCH.GT.INCH) NCH=INCH
      C
      C     INITILIZE OUTPUT FILE
      C
0066  50    WRITE(IOUT,51)
0067  51    FORMAT(' FILENAME FOR DATA OUTPUT'/)
0068        READ(IN,52) LEN,IDAT
0069  52    FORMAT(Q,80A1)
0070        DO 54 I=1,LEN
0071  54    IF(IDAT(I).EQ.PERIOD) IDAT(I)=BLANK
0073        N=2
0074        NA=1
0075        M=1
0076        ITYPE=3
0077        CALL FREEFM(N,M,NA,ITYPE)
0078        FILDEF(2)=ALPHA(1)
0079        FILDEF(4)=ALPHA(2)
0080        IF(NX.LT.2) FILDEF(4)=BLANK
0082        CALL MCLI(FILDEF)
0083        NMFL=0
0084        CALL OANDC(NFILE,NERR,NDEV,NABS,NVLS,NDTY,NRCZ,NBYL,NMFL)
0085        DEFINE FILE NFILE(4096,2,U,IV)
      C
0086        WRITE(IOUT,56)
0087  56    FORMAT(' PRINT OUT CONDENSED SPECTRA, YES OR NO?',$)
0088        READ(IN,58) IANS
0089  58    FORMAT(A1)
0090        NPRT=0
0091        IF(IANS.EQ.YES) NPRT=1
      C
      C     INITIALIZE MAGTAPE
      C
0093        MODE=1
0094        CALL DATIN(MODE,NR)
      C
```

```
C
C       SKIP FILES ON TAPE
C
  60    IF(NXREC.LT.0) GOTO 62
        IF(NFSKIP.EQ.0) GOTO 64
  62    MODE=5
        NR=NFSKIP
        CALL DATIN(MODE,NR)
        NXREC=0
C
C       READ HEADER RECORD
C
  64    IF(NXREC.GT.0) GOTO 65
        MODE=4
        NR=NXREC
        CALL DATIN(MODE,NR)
  65    NTIME=10*(NREC2-NREC1+1)
        WRITE(LP,66)(HEADER(I),I=1,10),NREC1,NREC2,NTIME
  66    FORMAT(1H1,2X,7A2,3I6/' RECORDS',I5,' TO',I5,
       1     ',',I5,' SECONDS'/)
        WRITE(IOUT,67)(HEADER(I),I=1,10),NREC1,NREC2,NTIME
  67    FORMAT(1H ,2X,7A2,/3I6/' RECORDS',I5,' TO',I5,
       1     ',',I5,' SECONDS'/)
        NXREC=1
        IV=1
        DO 68 I=1,10,2
  68    WRITE(NFILE'IV) HEADER(I),HEADER(I+1)
        WRITE(NFILE'IV) NREC1,NREC2
        WRITE(NFILE'IV) NTIME,NCH
        WRITE(NFILE'IV) MS,MF
C
C       SKIP RECORDS
C
  69    IF(NRSKIP.EQ.0) GOTO 70
        MODE=6
        NR=NRSKIP
        CALL DATIN(MODE,NR)
        NXREC=NXREC+NRSKIP
```

```
      CC
      C      MAIN LOOP
      C
0126  70     NRSTOP=9999
0127         KPRT=0
0128         DO 100 I=1,NRSTOP
0129         MODE=0
0130         NR=NXREC
0131         CALL DATIN(MODE,NR)
0132         NXREC=NR+1
0133         IF(NR.LT.NREC1) GOTO 100
0135         IF(NDEL.LT.1) GOTO 78
0137         DO 74 J=1,NDEL
0138  74     IF(NR.EQ.NDREC(J)) DATA(15)=-999
0140  78     IF(KPRT.NE.0) GOTO 90
0142   80    CALL BTIME(IDAY,IYR,IHR,IMIN,ISEC)
0143         WRITE(IOUT,81) NR,IHR,IMIN,ISEC
0144   81    FORMAT(' BEGINNING AT RECORD',I4,
            *             ', AT ',I2,':',I2,':',I2/)
0145         KPRT=1
0146   90    IF(NR.GE.NREC2) I=NRSTOP
0148         IF(NR.LT.9999) GOTO 92
0150         I=NRSTOP
0151         NR=NXREC-1
0152         GOTO 96
0153   92    CALL DATOUT(MS,MF,NCH,NFILE,NPRT,IV)
0154         IF(MOD(NR,100).NE.0) GOTO 96
0156         IF(NR.GE.9999) NR=NXREC-1
0158         CALL BTIME(IDAY,IYR,IHR,IMIN,ISEC)
0159         WRITE(IOUT,95) NR,IHR,IMIN,ISEC
0160  95     FORMAT(' PROCESSING COMPLETED THROUGH RECORD ',I54,
            *             ', AT ',I2,':',I2,':',I2/)
0161  96     IF(I.LT.NRSTOP) GOTO 100
0163         CALL BTIME(IDAY,IYR,IHR,IMIN,ISEC)
0164         WRITE(IOUT,97) NR,IHR,IMIN,ISEC
0165  97     FORMAT(' THE END RECORD IS',I5,
            *             ', AT ',I2,':',I2,':',I2/)
0166  100    CONTINUE
```

```
C
C       END OF MAIN LOOP
C
C       CLOSE OUTPUT FILE
        ENDFILE NFILE
        CALL CLOSEU(NFILE)
C
        IF(IRPT.EQ.1) WRITE(LP,120)
  120   FORMAT(1H1)
        WRITE(IOUT,150)
  150   FORMAT(' DO YOU WISH TO CONTINUE?',/)
        READ(IN,200) NEWOP
    200 FORMAT(A1)
        IF(NEWOP.EQ.YES) GO TO 10
C
C       CLOSE MAGTAPE
C
 1000   MODE=10
        CALL DATIN(MODE,NR)
        WRITE(LP,1010)
 1010   FORMAT(1H1)
        END
```

MIDAS FORTRAN IV STORAGE MAP

NAME	OFFSET	ATTRIBUTES	
NDREC	000006	INTEGER*2	ARRAY (16)
FILDEF	000046	REAL*8	ARRAY (5)
YES	[illegible]	INTEGER*2	VARIABLE
PERIOD	[illegible]	INTEGER*2	VARIABLE
BLANK	[illegible]	INTEGER*2	VARIABLE
NBLANK	[illegible]	REAL*4	VARIABLE
IOUT	000124	INTEGER*2	VARIABLE
IN	000126	INTEGER*2	VARIABLE
LP	000130	INTEGER*2	VARIABLE
NXREC	000132	INTEGER*2	VARIABLE
NFILE	000134	INTEGER*2	VARIABLE
NCH	000136	INTEGER*2	VARIABLE
INCH	000140	INTEGER*2	VARIABLE
MS	000142	INTEGER*2	VARIABLE
MF	000144	INTEGER*2	VARIABLE
NDEL	000152	INTEGER*2	VARIABLE
NFSKIP	000154	INTEGER*2	VARIABLE
NRSKIP	000156	INTEGER*2	VARIABLE
IBLK	000160	INTEGER*2	VARIABLE
N	001260	INTEGER*2	VARIABLE
M	001262	INTEGER*2	VARIABLE
NA	001264	INTEGER*2	VARIABLE
ITYPE	001266	INTEGER*2	VARIABLE
FREEFM	000000	REAL*4	PROCEDURE
NREC1	001270	INTEGER*2	VARIABLE
NREC2	001272	INTEGER*2	VARIABLE
L	001274	INTEGER*2	VARIABLE
I	001276	INTEGER*2	VARIABLE
LEN	001300	INTEGER*2	VARIABLE
NX	001302	INTEGER*2	VARIABLE
MCLI	000000	INTEGER*2	PROCEDURE
NMFL	001304	INTEGER*2	VARIABLE
OANDC	000000	REAL*4	PROCEDURE
MERR	001306	INTEGER*2	VARIABLE
NDEV	001310	INTEGER*2	VARIABLE
NABS	001312	INTEGER*2	VARIABLE
NVLS	001314	INTEGER*2	VARIABLE
NDTY	001316	INTEGER*2	VARIABLE
NRCZ	001320	INTEGER*2	VARIABLE
NBYL	001322	INTEGER*2	VARIABLE
IV	001324	INTEGER*2	VARIABLE
IANS	001326	INTEGER*2	VARIABLE
NPRT	001330	INTEGER*2	VARIABLE
MODE	001332	INTEGER*2	VARIABLE
DATIN	000000	REAL*4	PROCEDURE
NR	001334	INTEGER*2	VARIABLE
NTIME	001336	INTEGER*2	VARIABLE
NRSTOP	001340	INTEGER*2	VARIABLE
KPRT	001342	INTEGER*2	VARIABLE
J	001344	INTEGER*2	VARIABLE
BTIME	000000	REAL*4	PROCEDURE
IDAY	001346	INTEGER*2	VARIABLE
IYR	001350	INTEGER*2	VARIABLE
IHR	001352	INTEGER*2	VARIABLE
IMIN	001354	INTEGER*2	VARIABLE
ISEC	001356	INTEGER*2	VARIABLE
DATOUT	000000	REAL*4	PROCEDURE
MOD	000000	INTEGER*2	PROCEDURE
CLOSEU	000000	REAL*4	PROCEDURE
NEWOP	001360	INTEGER*2	VARIABLE

COMMON BLOCK /ARRAY/ LENGTH 004600

DATA	000000	INTEGER*2	ARRAY (1024)
HEADER	004000	INTEGER*2	ARRAY (256)

COMMON BLOCK /DATA/ LENGTH 000240

IDAT	000000	INTEGER*2	ARRAY (80)

COMMON BLOCK /FREE/ LENGTH 000340

INTEG	000000	INTEGER*2	ARRAY (16)
REALX	000040	REAL*4	ARRAY (16)
ALPHA	000140	REAL*8	ARRAY (16)

```
[illegible] LINKER      V02-A-[illegible]     LOAD MAP     3 JAN 1985  8:54:38 AM

SECTION ADDR   SIZE   ENTRY  ADDR   ENTRY  ADDR   ENTRY  ADDR
. ABS.  000000 001000 $LPECL 000210 $NLCHN 000006 $USRSW 000200
                      $RF1B3 000000
. ABS.  00[illegible] 000000 $TRACE 004737
. ABS.  000000 000000 $V004A 000001
.[illegible] [illegible] 001254 .[illegible]. 010000
[illegible] [illegible] [illegible]
ARRAY & 001254 0[illegible] ARRAY  001254
ARRAY & 001254 024000
ARRAY & 0[illegible]254 02[illegible]000
DATA  & 025254 000240 DATA   025254
DATA  & 025254 000240
FREE  & 025514 006340 FREE   025514
FREE  & 025514 000340
        026054 005302
        033356 001310 DATOUT 033356
        034666 002672 DATIN  034666
        037560 000354 IBCD   037560
        040134 000210 ILSHFT 040134
        040344 002106 FREEFM 040344
        042452 000060 NMI$II 042452 NMI$MI 042500 NMI$PI 042506
                      NPI$II 042516 NPI$MI 042522 NPI$PI 042526
        042532 000064 NMI$IP 042532 NMI$MP 042564 NMI$PP 042572
                      NPI$IP 042602 NPI$MP 042606 NPI$PP 042612
        042516 000044 NMI$1P 042616 NPI$1I 042636 NPI$1M 042650
                      NPI$1P 042632
        042662 000040 MOD    042662
        042722 000110 TAD$   042752 TAF$   042760 TAI$   042722
                      TAL$   042730 TAP$   042744 TAQ$   042736
        043032 000056 $DTIS  043032
        043110 000210 ISN$   043115 LSN$   043130 $ISNTR 043114
                      $LSNTR 043134
        043320 000046 EOL$   043320
        04[illegible]366 000066 DEO$   043366
        043454 000044 RET$   043470 RET$F  043460 RET$I  043466
                      RET$L  043454
        043520 001106 IBR$   043526 IBW$   043520 $IBW   043532
        044626 000072 ENC$   044626
        044720 000020 IFR$   044720 IFW$   044732
        044740 001562 $FIO   045426
        046522 002344 DCO$   050146 ECO$   050140 FCO$   050134
                      GCO$   050126 ICI$   046530 ICO$   047702
                      OCI$   046522 OCO$   047674 RCI$   046724
                      $GET   046710
        051066 000110 $DUMPL 051066
        051176 000036 $GETFI 051176
        051234 000042 DII$IS 051246 DII$MS 051242 DII$PS 051234
                      DII$SS 051250 $DVI   051250
        051276 000040 MUI$IS 051310 MUI$MS 051304 MUI$PS 051276
                      MUI$SS 051312 $MLI   051312
        051336 000120 $FCHNL 051336
        051456 000044 BGE$   051476 BGE$   051506 BGT$   051504
```

		BLE$	051474	BLT$	051516	BNE$	051514
		BPL$	051510	NMI$II	051466	NMI$IM	051456
051522	000002	$AOTS	051522				
051524	000100	CCI$	051524	CDI$	051524	CFI$	051540
		$IC	051524	$ID	051524	$IR	051540
[illegible]	[illegible]	$WAIT	[illegible]				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	051732
		[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	051740		
[illegible]	[illegible]	MOI$RA	052002	MOI$RM	051774	MOI$RP	[illegible]
		MOI$RS	051770	MOL$RS	051770		
052006	000102	MOI$IA	052032	MOI$IM	052026	MOI$IS	052022
		MOI$MA	052046	MOI$MM	052042	MOI$MS	052036
		MOI$SA	052016	MOI$SM	052012	MOI$SS	052006
		MOI$OA	052062	MOI$OM	052056	MOI$OS	052052
		MOI$1A	052102	MOI$1M	052074	MOI$1S	052066
		MOL$IS	052022	MOL$SS	052006	REL$	052022
052110	000046	CMI$IP	052110	CMI$MP	052120	CMI$PI	052142
		CMI$PM	052150	CMI$PP	052130	CMI$PS	052134
		CMI$SP	052112				
052156	000044	CMI$II	052176	CMI$IM	052202	CMI$IS	052172
		CMI$MI	052212	CMI$MM	052216	CMI$MS	052206
		CMI$SI	052162	CMI$SM	052166	CMI$SS	052156
052222	000034	DCI$A	052252	DCI$M	052244	DCI$P	052250
		DCI$S	052240	ICI$A	052234	ICI$M	052226
		ICI$P	052232	ICI$S	052222		
052256	000046	SUI$IP	052256	SUI$MP	052272	SUI$PA	052316
		SUI$PM	052310	SUI$PP	052266	SUI$PS	052302
		SUI$SP	052260				
052324	000044	SUI$IA	052344	SUI$IM	052350	SUI$IS	052340
		SUI$MA	052360	SUI$MM	052364	SUI$MS	052354
		SUI$SA	052330	SUI$SM	052334	SUI$SS	052324
052370	000046	ADI$IP	052370	ADI$MP	052404	ADI$PA	052430
		ADI$PM	052422	ADI$PP	052400	ADI$PS	052414
		ADI$SP	052372				
052436	000044	ADI$IA	052456	ADI$IM	052462	ADI$IS	052452
		ADI$MA	052472	ADI$MM	052476	ADI$MS	052466
		ADI$SA	052442	ADI$SM	052446	ADI$SS	052436
052502	000064	MOI$IP	052502	MOI$MP	052516	MOI$PA	052542
		MOI$PM	052534	MOI$PP	052512	MOI$PS	052526
		MOI$SP	052504	MOI$0P	052550	MOI$1P	052556
052566	000042	MOF$MA	052600	MOF$MM	052566	MOF$MP	052606
		MOF$PA	052620	MOF$PM	052614	MOF$PP	052624
052630	000032	SAI$IM	052630	SAI$MM	052652	SAI$SM	052632
		SVI$IM	052640	SVI$MM	052656	SVI$SM	052642
052662	000032	TSD$I	052702	TSD$M	052676	TSD$P	052706
		TSD$S	052666	TSF$I	052702	TSF$M	052676
		TSF$P	052706	TSF$S	052672	TSI$I	052702
		TSI$M	052676	TSI$P	052706	TSI$S	052662
052714	000034	CPD$SM	052730	CPF$SM	052724	CPI$SM	052720
		CPL$SM	052714				
052750	000030	LEQ$	052772	LGE$	052762	LGT$	052750
		LLE$	052750	LLT$	052774	LNE$	052772

```
        053000 000024 TSL$I  053010 TSL$M  053004 TSL$P  053016
                      TSL$S  053000
        053024 000044 SAF$IM 053024 SAF$MM 053060 SAF$SM 053026
                      SVF$IM 053036 SVF$MM 053064 SVF$SM 053040
        053070 000046 MOD$MA 053116 MOD$MM 053106 MOD$MP 053074
                      MOD$PA 053114 MOD$PM 053102 MOD$PP 053070
        053136 000020 MOD$IM 053142 MOD$SP 053136
        053156 000044 SAD$IM 053156 SAD$MM 053212 SAD$SM 053160
                      SVD$IM 053172 SVD$MM 053216 SVD$SM 053174
        053222 000030 MOD$MS 053232 MOD$PS 053226 MOD$SS 053222
                      MOD$VS 053214
IOPKG   053252 001034 DCLOSE 053552 DOPEN  053252 DREAD  053454
                      DRUN   054074 DWAIT  053660 DWRITE 053552
                      IAND   054026 IOR    054044 LSHIFT 054056
MTAPEX  054306 002156 MTAPEF 054306
MTULSU  056464 003762 MTULS  056464
STIME$  062446 000100 BTIME  062446
MCLI$   062546 000632 MCLI   062546
CLOSU   063400 000032 CLOSEU 063400
OANDCX  063432 000356 DCB    063746 OAC3   063720 OANDC  063432
$M.TVT  064010 000062 TVD$   064024 TVF$   064016 TVI$   064046
                      TVL$   064010 TVP$   064040 TVQ$   064032
OT      064072 001510 $ERRS$ 064602 $FPERR 064444 $OTI   064072
STOP    065602 000112 EXIT   065626 FOO$   065602 STP$   065626
RIO     065714 000600 DEF$   066430 IRR$   065714 IRW$   065720
                      $GETIN 066300
GETREC  066514 000346 $GETRE 066514 $TTYIN 067014
ENDFIL  067062 000042 EOF$   067062
CLOSS   067124 000550 $CLOSE 067124
OUTREC  067674 000414 $PUTRE 067674
$M.FIO  070310 000216 $FMTDR 070310 $FMTDW 070344 $INITI 070416
OPEN    070526 000610 $OPEN  070526
RWBLK   071336 000460 $EOFIL 071746 $GETBL 071560 $PUTBL 071336
ERRTB   072016 000100 $ERRTB 072016
ERRS    072116 002570 $ERRS  072116
$M.LCV  074706 000106 LCI$   074706 LCO$   074754
```

SEGMENT PARAMETER TABLE

```
SEG  SIZE   LIMIT
 0  055014 075014

PROGRAM SIZE = 055014
DATA AREA SIZE = 000000
TRANSFER ADDRESS = 026054
STACK SIZE = 001000
```

```
0001          SUBROUTINE FREEFM(N,M,NA,ITYPE)
        C     LAST REVISED AUGUST 1981 BY G.W.P.
        C
        C     GENERAL SUBROUTINE TO DECODE DATA READ IN FREE FIELD FORMAT
        C     DELIMITERS ARE EITHER A BLANK OR A COMMA
        C     THE ROUTINE ASSUMES THE DATA HAS BEEN READ INTO ARRAY IDATA WITH
        C        THE FORMAT (80A1)
        C     N IS THE NUMBER OF DATA ELEMENTS, MAXIMUM=16
        C     N IS RETURNED AS THE NUMBER OF DATA ELEMENTS FOUND
        C     M IS THE LOCATION IN THE ARRAY FOR STORING THE FIRST DATA ELEMENT
        C     M IS RETURNED AS THE LOCATION FOLLOWING THE NTH DATA ELEMENT
        C     NA IS THE BEGINNING COLUMN OF THE DATA
        C     NA IS RETURNED AS THE COLUMN FOLLOWING THE NTH DATA ELEMENT
        C     ITYPE IS THE TYPE OF DATA.
        C        1=INTEGER
        C        2=REAL
        C        3=ALPHANUMERIC
        C
0002          COMMON/DATA/IDATA(80)
0003          COMMON/FREE/INTEG(16),REALX(16),ALPHA(16)
0004          INTEGER SEMI,E,COMMA
0005          REAL*8 ALPHA,BLANK
0006          DIMENSION ITEMP(20),AFORM(2)
0007          DATA SEMI,E,IBLK1,COMMA,IBLK2,BLNK4,BLANK
             * /';','E',' ',',','    ','        '/
        C
0008          L=M
0009          M=M+N-1
0010          DO 300 I=L,M
0011          IF(NA.GT.80) GO TO 400
        C
        C     LOOK FOR START OF CURRENT FIELD
        C
0013          DO 210 J=NA,80
0014          JQQ=J
0015             IF(IDATA(J).NE.IBLK1) GO TO 215
0017     210  CONTINUE
0018             NA=81
0019             GO TO 400
0020     215  IF(IDATA(JQQ).NE.COMMA) GO TO 220
0022             NA=JQQ+1
0023             GO TO 290
```

```
      C
      C     LOOK FOR END OF CURRENT FIELD
      C
       220  IL=JQQ
            ILQ = IL
       221  DO 230 J=ILQ,80
            JQQ=J
               IF(IDATA(J).EQ.IBLK1) GO TO 235
               IF(IDATA(J).NE.COMMA) GO TO 230
                  IR=J-1
                  NA=J+1
                  GO TO 250
       230  CONTINUE
               IR=80
               NA=81
               GO TO 250
      C
      C     CHECK FOR EXPONENT
      C
       235  IF((ITYPE.NE.2).OR.(IDATA(JQQ-1).NE.E)) GO TO 236
            ILQ = JQQ + 1
            GO TO 221
       236  IR=JQQ - 1
            IJ=JQQ+1
      C
      C     SET NA TO START OF NEXT FIELD
      C
            DO 240 J=IJ,80
               IF(IDATA(J).EQ.IBLK1) GO TO 240
                  NA=J
                  IF(IDATA(J).EQ.COMMA) NA=NA+1
                  GO TO 250
       240  CONTINUE
               NA=81
      C
      C     ENCODE DATA IN CURRENT FIELD
      C
       250  NI=IR-IL+1
            IF(NI.LT.1) GO TO 290
            ENCODE(NI,255,ITEMP) (IDATA(J),J=IL,IR)
       255  FORMAT(83A1)
```

```
C
100   CALL KLIN(K,Y1,Y2,NR,NID,M,MS,MF)
      IF(NR.LT.0) GOTO 300
      IF(INIT.NE.0) GOTO 102
      CALL KINIT(X1,X2,Y1,Y2,H,V1,V2,P1,P2,Q1,Q2,
     *     S1,S2,N1,N2,M,MS,MF)
      CALL BTIME(IDAY,IYR,IHR,IMIN,ISEC)
      WRITE(ICRT,101)NR,IHR,IMIN,ISEC
101   FORMAT('0BEGINNING AT RECORD ',I4,
     *     ', AT ',I2,':',I2,':',I2/)
      INIT=1
102   IF(NID.EQ.1.OR.NID.EQ.2.OR.NID.EQ.3) GOTO 105
      IF(NID.GT.10.AND.NID.LT.100) GOTO 105
      WRITE(LP,104)NR,NID
104   FORMAT(I5,I3)
      GOTO 100
C
105   L=N1
D     WRITE(ICRT,110)K,NR
D110  FORMAT(' POD 1. CALLING KSTEP, STEP',I4,', RECORD',I4/)
      CALL KSTEP(K,X1,Y1,S1,Q,Q1,R1,N1,M,NR)
D     WRITE(ICRT,120)
D120  FORMAT(' CALLING DDKALM'/)
      CALL DDKALM(K,X1,H,Y1,S1,Q,R1,V1,
     1     IN,IS,IL,N1,M,L,T1,T2,IT,T3,IER)
      DO 200 J=1,M
200   R1(J)=T3(J)
      DO 210 I=1,N1
210   P1(I)=V1(I,I)
      L=N2
D     WRITE(ICRT,212)K,NR
D212  FORMAT(' POD 2. CALLING KSTEP, STEP',I4,', RECORD',I4/)
      CALL KSTEP(K,X2,Y2,S2,Q,Q2,R2,N2,M,NR)
D     WRITE(ICRT,214)
D214  FORMAT(' CALLING DDKALM'/)
      CALL DDKALM(K,X2,H,Y2,S2,Q,R2,V2,
     1     IN,IS,IL,N2,M,L,T1,T2,IT,T3,IER)
      DO 220 J=1,M
220   R2(J)=T3(J)
      DO 230 I=1,N2
230   P2(I)=V2(I,I)
      K=K+1
D     WRITE(ICRT,240)
D240  FORMAT(' CALLING KOUT')
      CALL KOUT(K,NR,NID,X1,X2,P1,P2,Y1,Y2,S1,S2,
     1     Q1,Q2,R1,R2,N1,N2,M,MS,MF)
      IF(MOD(NR,50).NE.0) GOTO 250
      CALL BTIME(IDAY,IYR,IHR,IMIN,ISEC)
      WRITE(ICRT,250) NR,IHR,IMIN,ISEC
250   FORMAT(' PROCESSING COMPLETED THROUGH RECORD',I4,
     *     ', AT ',I2,':',I2,':',I2,/)
300   IF(NR.GE.0) GOTO 100
```

```
      C      PROGRAM KFILTR
      C      RUNS KALMAN FILTER FOR NIAGARA DATA
      C      LAST MODIFIED BY G.W.PHILLIPS, JANUARY 1985
      C
0001         REAL*4 X1(8),X2(8),H(8),Q(8),V1(8,8),V2(8,8)
0002         REAL*4 Y1(16),Y2(16),R1(16),R2(16)
0003         REAL*4 T1(16,16),T2(16,16),T3(16)
0004         REAL*4 S1(16,8),S2(16,8),O1(8),O2(8),P1(8),P2(8)
0005         DATA K/0/,IN/8/,IL/8/,IS/16/,IT/16/,NR/0/,ICRT/5/,LP/6/
0006         DATA INIT/0/
      C
```

```
MIDAS FORTRAN IV   STORAGE MAP

NAME     OFFSET  ATTRIBUTES

Y1       000016  REAL*4     PARAMETER ARRAY (16)
Y2       000020  REAL*4     PARAMETER ARRAY (16)
IY       000034  INTEGER*2 ARRAY (16)
IDATE    000074  INTEGER*2 ARRAY (12)
IREC     000124  INTEGER*2 ARRAY (16)
FILDEF   000164  REAL*8     ARRAY (5)
K        000014  INTEGER*2 PARAMETER VARIABLE
NR       000022  INTEGER*2 PARAMETER VARIABLE
NID      000024  INTEGER*2 PARAMETER VARIABLE
NCH      000026  INTEGER*2 PARAMETER VARIABLE
MS       000030  INTEGER*2 PARAMETER VARIABLE
MF       000032  INTEGER*2 PARAMETER VARIABLE
PERIOD   000240  INTEGER*2 VARIABLE
BLANK    000242  INTEGER*2 VARIABLE
IV       000234  INTEGER*2 VARIABLE
LP       000236  INTEGER*2 VARIABLE
IN       000244  INTEGER*2 VARIABLE
IOUT     000246  INTEGER*2 VARIABLE
NFILE    000250  INTEGER*2 VARIABLE
IBLK     000252  INTEGER*2 VARIABLE
INIT     000254  INTEGER*2 VARIABLE
LREC1    000256  INTEGER*2 VARIABLE
LREC2    000260  INTEGER*2 VARIABLE
NDEL     000262  INTEGER*2 VARIABLE
LEN      001174  INTEGER*2 VARIABLE
I        001176  INTEGER*2 VARIABLE
N        001200  INTEGER*2 VARIABLE
NA       001202  INTEGER*2 VARIABLE
M        001204  INTEGER*2 VARIABLE
ITYPE    001206  INTEGER*2 VARIABLE
FREEFM   000000  REAL*4     PROCEDURE
MCLI     000000  INTEGER*2 PROCEDURE
NREC1    001210  INTEGER*2 VARIABLE
NREC2    001212  INTEGER*2 VARIABLE
NTIME    001214  INTEGER*2 VARIABLE
MAX0     000000  INTEGER*2 PROCEDURE
MIN0     000000  INTEGER*2 PROCEDURE
ATIME    000000  REAL*4     PROCEDURE
LR       001216  INTEGER*2 VARIABLE

COMMON BLOCK /DATA/      LENGTH 000240

IDATA    000000  INTEGER*2 ARRAY (80)

COMMON BLOCK /FREE/      LENGTH 000340

INTEG    000000  INTEGER*2 ARRAY (16)
REALX    000040  REAL*4     ARRAY (16)
ALPHA    000140  REAL*8     ARRAY (16)

COMMON BLOCK /HDR/       LENGTH 000024

HEADER   000000  INTEGER*2 ARRAY (10)

COMMON BLOCK /IO/        LENGTH 000004

IO1      000000  INTEGER*2 VARIABLE
IO2      000002  INTEGER*2 VARIABLE
```

```
      C
      C      READ OBSERVED SPECTRA FOR PODS 1 AND 2
      C
0084  200    IF(LR.LT.NREC2) GOTO 210
0085         NR=-NR
0087         RETURN
      C
0088  210    READ(NFILE'IV,END=300)NR,NID
0089         IF(NR.NE.LR+1) NID=0
0091         IF(NR.GT.0) GOTO 220
0093         NR=0
0094         IF(NID.GT.0) NID=-NID
      C
0096  220    LR=NR
0097         DO 230 I=1,NCH,2
0098  230    READ(NFILE'IV,END=300) IY(I),IY(I+1)
0099         DO 240 I=1,NCH
0100  240    Y1(I)=IY(I)
0101         DO 260 I=1,NCH,2
0102  260    READ(NFILE'IV,END=300) IY(I),IY(I+1)
0103         DO 270 I=1,NCH
0104  270    Y2(I)=IY(I)
0105         IF(NR.LT.NREC1) GOTO 210
0107         IF(NDEL.LE.0) GOTO 280
0109         DO 274 I=1,NDEL
0110  274    IF(NR.EQ.NDREC(I)) NID=-999
      C
0112  280    CONTINUE
      D      WRITE(LP,282)NR,NID,(Y1(I),I=1,NCH)
      D282   FORMAT(1H0,'OBSERVED VECTORS, RECORD',I4,' MODE',I4/
      D     1     1X,'POD 1',8G13.3/(7X,8G13.3))
      D      WRITE(LP,284)(Y2(I),I=1,NCH)
      D284   FORMAT(1X,'POD 2',8G13.3/(7X,8G13.3))
0113         RETURN
      C
0114  300    WRITE(IOUT,310) NR
0115  310    FORMAT(' PREMATURE END OF DATA AT RECORD',I4/)
0116         NR=-NR
0117         RETURN
0118         END
```

```
      C
0043           NDEL=0
0044           WRITE(IOUT,132)
0045  132      FORMAT(' ENTER UP TO 16 BAD RECORDS TO DELETE'/)
0046  133      READ(IN,134) LEN,IDATA
0047  134      FORMAT(Q,80A1)
0048           IF(LEN.LE.0) GOTO 140
0050           N=16-NDEL
0051           IF(N.LE.0) GOTO 140
0053           M=1
0054           NA=1
0055           ITYPE=1
0056           CALL FREEFM(N,M,NA,ITYPE)
0057           IF(N.LE.0) GOTO 140
0059           DO 135 I=1,N
0060  135      NDREC(NDEL+I)=INTEG(I)
0061           NDEL=NDEL+N
0062           GOTO 133
      C
0063  140      CALL MCLI(FILDEF)
0064           IV=1
0065           DEFINE FILE NFILE(4096,2,U,IV)
0066           DO 142 I=1,10,2
0067  142      READ(NFILE'IV,END=300) HEADER(I),HEADER(I+1)
0068           READ(NFILE'IV,END=300)NREC1,NREC2
0069           READ(NFILE'IV,END=300)NTIME,NCH
0070           READ(NFILE'IV,END=300)MS,MF
0071           NREC1=MAX0(NREC1,LREC1)
0072           NREC2=MIN0(NREC2,LREC2)
0073           CALL ATIME(KDATE)
0074           WRITE(LP,144) (HEADER(I),I=1,7),KDATE
0075  144      FORMAT(1H1,2X,7A2,3X,'PROCESSED ON ',12A2)
0076           WRITE(LP,145) NREC1,NREC2,NTIME,MS,MF,NCH
0077  145      FORMAT(3X,'RECORDS',I5,' TO',I5,
              1     2X,I5,' SECS'/
              2     ' STARTING CHANNEL=',I5,
              3     ', FINAL CHANNEL=',I5,
              4     ', CONDENSED TO',I3,' CHANNELS FOR FILTER')
0078           WRITE(LP,148) IQ1,IQ2
0079  148      FORMAT(' FINAL LEARNING RECORDS FOR INPUT VARIANCE'/
              1     4X,I5,' FOR POD 1,',I5,' FOR POD 2'/)
0080           WRITE(IOUT,150) (HEADER(I),I=1,7),NREC1,NREC2
0081  150      FORMAT(1X,7A2/' RECORDS',I5,' TO',I5/)
0082           INIT=1
0083           LR=NREC1-1
```

```
      SUBROUTINE KLIN(K,Y1,Y2,NR,NID,NCH,MS,MF)
C     READS IN DATA FOR KALMAN FILTER
C     LAST MODIFIED BY G.W.PHILLIPS, JANUARY 1985
      DIMENSION Y1(16),Y2(16),IY(16)
      INTEGER PERIOD,BLANK,HEADER(10),KDATE(12),NDREC(16)
      REAL*8 ALPHA,FILDEF(5)
      COMMON /DATA/IDATA(80)/FREE/INTEG(16),REALX(16),ALPHA(16)
      COMMON/HDR/HEADER
      COMMON/IQ/IQ1,IQ2
      DATA FILDEF/8H@DEF 12 ,1H ,1H.,1H .1H@/,IV/0/,LP/6/
      DATA PERIOD/1H./,BLANK/1H /,IN/5/,IOUT/5/,NFILE/12/
      DATA IQ1/9999/,IQ2/9999/,IBLK/2H  /,INIT/0/
      DATA LREC1/0/,LREC2/9999/,NDEL/0/
C
C     INITIALIZE FILE AND READ IN HEADER
C
      IF(INIT.NE.0) GOTO 200
100   WRITE(IOUT,110)
110   FORMAT(' FILENAME FOR OBSERVED SPECTRA (,START,STOP RECORDS,'/
     1    4X,'LAST LEARNING RECORDS FOR VARIANCE: POD 1,POD 2)'/)
      READ(IN,120)LEN,IDATA
120   FORMAT(Q,80A1)
      IF(LEN.LT.1) GOTO 100
      DO 130 I=1,LEN
130   IF(IDATA(I).EQ.PERIOD) IDATA(I)=BLANK
      N=2
      NA=1
      M=1
      ITYPE=3
      CALL FREEFM(N,M,NA,ITYPE)
      FILDEF(2)=ALPHA(1)
      FILDEF(4)=ALPHA(2)
      IF(N.LT.2) FILDEF(4)=BLANK
      N=4
      M=1
      CALL FREEFM(N,M,NA,1)
      IF(INTEG(1).NE.IBLK) LREC1=INTEG(1)
      IF(INTEG(2).NE.IBLK) LREC2=INTEG(2)
      IF(INTEG(3).NE.IBLK) IQ1=INTEG(3)
      IF(INTEG(4).NE.IBLK) IQ2=INTEG(4)
```

```
MIDAS FORTRAN IV   STORAGE MAP

NAME     OFFSET  ATTRIBUTES

I1       000030  INTEGER*2 ARRAY (32)
I2       000130  INTEGER*2 ARRAY (32)
MS       000014  INTEGER*2 PARAMETER VARIABLE
MF       000016  INTEGER*2 PARAMETER VARIABLE
NCH      000020  INTEGER*2 PARAMETER VARIABLE
NFILE    000022  INTEGER*2 PARAMETER VARIABLE
NPRT     000024  INTEGER*2 PARAMETER VARIABLE
IV       000026  INTEGER*2 PARAMETER VARIABLE
NREC     000262  INTEGER*2 VARIABLE
NID      000264  INTEGER*2 VARIABLE
MR       000266  INTEGER*2 VARIABLE
ML       000270  INTEGER*2 VARIABLE
IJ       000272  INTEGER*2 VARIABLE
J        000274  INTEGER*2 VARIABLE
MJ       000276  INTEGER*2 VARIABLE
L1       000300  INTEGER*2 VARIABLE
L2       000302  INTEGER*2 VARIABLE
I        000304  INTEGER*2 VARIABLE
M        000306  INTEGER*2 VARIABLE

COMMON BLOCK /ARRAY/    LENGTH 004000

DATA     000000  INTEGER*2 ARRAY (1024)
```

```
      SUBROUTINE DATOUT(MS,MF,NCH,NFILE,NPRT,IV)
C     CONDENSES NIAGARA DATA AND WRITES OUT FOR KALMAN FILTER
C     WRITTEN BY G. PHILLIPS, JUNE 1981
C
      INTEGER DATA(1024),I1(32),I2(32)
      COMMON/ARRAY/DATA
C
C     EXTRACT OBSERVED SPECTRA FOR PODS 1 AND 2
C
      NREC=DATA(3)
      NID=DATA(15)
      IF(MS.LT.3) MS=3
      IF(MF.GT.255) MF=255
      IF(NCH.GT.32) NCH=32
C
C     CONDENSE SPECTRA TO NCH CHANNELS
C
      MR=MF-MS+1
      ML=(MR+NCH-1)/NCH
      IJ=0
      DO 160 J=MS,MF,ML
      MJ=J+ML-1
      IF(MJ.GT.MF) MJ=MF
      L1=0
      L2=0
      DO 140 I=J,MJ
      L1=L1+DATA(I+512)
      L2=L2+DATA(I+768)
  140 CONTINUE
      IJ=IJ+1
      I1(IJ)=L1
      I2(IJ)=L2
  160 CONTINUE
      M=IJ
C
C     WRITE TO OUTPUT FILE
C
  200 WRITE(NFILE'IV)NREC,NID
      DO 220 I=1,NCH,2
  220 WRITE(NFILE'IV) I1(I),I1(I+1)
      DO 240 I=1,NCH,2
  240 WRITE(NFILE'IV) I2(I),I2(I+1)
      IF(NPRT.EQ.0) RETURN
C
      WRITE(6,260) NREC,NID,(I1(I),I=1,NCH)
  260 FORMAT(1X,2I4,8I8/(9X,8I8))
      WRITE(6,280) (I2(I),I=1,NCH)
  280 FORMAT(9X,8I8)
      RETURN
      END
```

```
      C
      C
      600   WRITE(IOUT,610)MODE
      610   FORMAT(1H0,'ILLEGAL MODE',I4,' CALLED TO TAPE READ SUBROUTINE')
            GOTO 1000
      C
      C     END OF FILE
      C
      800   NR=NR-1
            WRITE(IOUT,810) NR
      810   FORMAT(1H0,'END OF FILE AFTER RECORD',I4)
            NR=9999
            RETURN
      C
      C     WRITE ERROR CODES
      C
      900   CONTINUE
      910   IF(IB.NE.2) GOTO 920
            WRITE(IOUT,911)
      911   FORMAT(1H0,'TRANSPORT NOT OPEN')
            GOTO 1000
      920   IF(IB.NE.20) GOTO 1000
            WRITE(IOUT,921)
      921   FORMAT(1H0,'TRANSPORT OFF LINE')
            GOTO 1000
      C
      1000  STOP
            END
```

```
MIDAS FORTRAN IV   STORAGE MAP


NAME     OFFSET  ATTRIBUTES

MODE     000014  INTEGER*2 PARAMETER VARIABLE
NR       000016  INTEGER*2 PARAMETER VARIABLE
IOUT     000020  INTEGER*2 VARIABLE
INIT     000022  INTEGER*2 VARIABLE
MTAPEF   000000  INTEGER*2 PROCEDURE
IB       000634  INTEGER*2 VARIABLE
I        000636  INTEGER*2 VARIABLE
ILSHFT   000000  INTEGER*2 PROCEDURE
IBCD     000000  INTEGER*2 PROCEDURE

COMMON BLOCK /ARRAY/    LENGTH 004000

DATA     000000  INTEGER*2 ARRAY (1024)
HEADER   000000  INTEGER*2 ARRAY (256)
```

```
      C
0060  400    IF(MODE.NE.7) GOTO 500
      C
      C      READ DATA RECORD
      C
      D      WRITE(IOUT,401) MODE,NR
      D401   FORMAT(' DATIN.MODE=',I3,'  RECORD=',I4)
0062         CALL MTAPEF(7,IB,0,2048,DATA)
0063         IF(IB.EQ.1) GOTO 440
0065         WRITE(IOUT,410)IB,NR
0066  410    FORMAT(1H0,'ERROR',I4,' IN DATA RECORD ',I4)
0067         IF(IB.EQ.2.OR.IB.EQ.20) GOTO 900
0069         IF(IB.EQ.9.OR.IB.EQ.22) GOTO 800
0071  440    CONTINUE
      D      WRITE(IOUT,441) NR
      D441   FORMAT(' RECORD',I4,' READ SUCCESSFULLY')
0072         DO 460 I=1,4
0073  460    DATA(I)=ILSHFT(DATA(I),8)
0074         DO 470 I=11,16
0075  470    DATA(I)=IBCD(DATA(I))                ! BCD TO DECIMAL CONVERSION
0076         DO 480 I=17,1024
0077  480    DATA(I)=ILSHFT(DATA(I),8)
0078         NR=DATA(3)
0079         RETURN
      C
      C      CLOSE TRANSPORT
      C
0080  500    IF(MODE.NE.10) GOTO 600
0082         CALL MTAPEF(16,IB)
0083         IF(IB.NE.1) WRITE(IOUT,510)IB
0085  510    FORMAT(' ERROR',I3,' IN MAGTAPE CLOSE')
0086         RETURN
```

```
      C
      C
0025  100   IF(MODE.NE.4) GOTO 200
      C
      C     READ HEADER RECORD
      C
0027        IF(NR.GT.0) RETURN
0029        CALL MTAPEF(7,IB,0,512,HEADER)
0030        NR=1
0031        IF(IB.EQ.1) GOTO 120
0033        WRITE(IOUT,110)IB
0034  110   FORMAT(1H0,'ERROR',I4,' IN HEADER RECORD READ')
0035        GOTO 900
0036  120   DO 140 I=1,3
0037  140   HEADER(I+7)=ILSHFT(HEADER(I+7),8)
0038        RETURN
      C
0039  200   IF(MODE.NE.5) GOTO 300
      C
      C     SKIP FILES ON TAPE
0041        IF(NR.EQ.0) RETURN
0043        CALL MTAPEF(5,IB,NR)
0044        NR=0
0045        IF(IB.EQ.1) RETURN
0047        WRITE(IOUT,210)IB
0048  210   FORMAT(1H0,'ERROR',I4,' ON FILE SKIP')
0049        GOTO 900
      C
0050  300   IF(MODE.NE.6) GOTO 400
      C
      C     SKIP RECORDS ON TAPE
      C
0052        IF(NR.EQ.0) RETURN
0054        CALL MTAPEF(6,IB,NR)
0055        IF(IB.EQ.1) RETURN
0057        WRITE(IOUT,310)IB
0058  310   FORMAT(1H0,'ERROR',I4,' IN RECORD SKIP')
0059        GOTO 900
```

```
      SUBROUTINE DATIN(MODE,NR)
C     NIAGARA TAPE READER
C     LAST MODIFIED BY G.W.PHILLIPS, APRIL 1982
C
      INTEGER DATA(1024),HEADER(256)
      EQUIVALENCE (DATA,HEADER)
      COMMON/ARRAY/DATA
      DATA IOUT/5/,INIT/0/
C
      IF(MODE.NE.1) GOTO 100
C
C     OPEN AND INITIALIZE MAGTAPE
C
      IF(INIT.EQ.1) RETURN
      CALL MTAPEF(15,IB,1)
      IF(IB.NE.1) WRITE(IOUT,10)IB
10    FORMAT(' ERROR',I3,' IN MAGTAPE OPEN'/)
      IF(IB.NE.20) GOTO 30
      WRITE(IOUT,20)
20    FORMAT (' TRANSPORT OFF LINE'/)
      STOP
C
30    CALL MTAPEF(1,IB)
      IF(IB.NE.1) WRITE(IOUT,35)IB
35    FORMAT(' ERROR',I3,' IN MAGTAPE INITIALIZE'/)
      INIT=1
      RETURN
```

```
MIDAS FORTRAN IV   STORAGE MAP

NAME     OFFSET  ATTRIBUTES

ITEMP    000024  INTEGER*2 ARRAY (20)
AFORM    000074  REAL*4    ARRAY (2)
N        000014  INTEGER*2 PARAMETER VARIABLE
M        000016  INTEGER*2 PARAMETER VARIABLE
NA       000020  INTEGER*2 PARAMETER VARIABLE
ITYPE    000022  INTEGER*2 PARAMETER VARIABLE
SEMI     000104  INTEGER*2 VARIABLE
E        000106  INTEGER*2 VARIABLE
COMMA    000112  INTEGER*2 VARIABLE
BLANK    000122  REAL*8    VARIABLE
IBLK1    000110  INTEGER*2 VARIABLE
IBLK2    000114  INTEGER*2 VARIABLE
BLNK4    000116  REAL*4    VARIABLE
L        000210  INTEGER*2 VARIABLE
I        000212  INTEGER*2 VARIABLE
J        000214  INTEGER*2 VARIABLE
JQQ      000216  INTEGER*2 VARIABLE
IL       000220  INTEGER*2 VARIABLE
ILQ      000222  INTEGER*2 VARIABLE
IR       000224  INTEGER*2 VARIABLE
IJ       000226  INTEGER*2 VARIABLE
NI       000230  INTEGER*2 VARIABLE

COMMON BLOCK /DATA/      LENGTH 000240

IDATA    000000  INTEGER*2 ARRAY (80)

COMMON BLOCK /FREE/      LENGTH 000340

INTEG    000000  INTEGER*2 ARRAY (16)
REALX    000040  REAL*4    ARRAY (16)
ALPHA    000140  REAL*8    ARRAY (16)
```

```
      C
      C
0059        GO TO (260,270,280),ITYPE
      C
      C     DECODE INTEGER DATA
      C
0060   260  ENCODE(8,265,AFORM) NI
0061   265  FORMAT('(I'I2,')    ')
0062        DECODE(NI,AFORM,ITEMP) INTEG(I)
0063        GO TO 300
      C
      C     DECODE REAL DATA
      C
0064   270  ENCODE(8,275,AFORM) NI
0065   275  FORMAT('(E'I2,'.0) ')
0066        DECODE(NI,AFORM,ITEMP) REALX(I)
0067        GO TO 300
      C
      C     DECODE ALPHANUMERIC DATA
      C
0068   280  IF(NI.GT.8) NI=8
0070        DO 287 J=1,NI
0071        IF(ITEMP(J).EQ.SEMI) ITEMP(J)=COMMA
0073   287  CONTINUE
0074        ENCODE(8,288,AFORM)NI
0075    288 FORMAT('(A',I1,')     ')
0076        DECODE(8,AFORM,ITEMP) ALPHA(I)
0077        GO TO 300
      C
      C     BLANK OUT REMAINING DATA
      C
0078  290   INTEG(I)=IBLK2
0079        REALX(I)=BLNK4
0080        ALPHA(I)=BLANK
0081   300  CONTINUE
0082        M=M+1
0083        RETURN
      C
      C     BLANK INPUT, BLANK OUT ALL DATA
      C
0084  400   DO 410 J=I,M
0085        INTEG(J)=IBLK2
0086        REALX(J)=BLNK4
0087        ALPHA(J)=BLANK
0088  410   CONTINUE
0089        M=I
0090        N=M-L
0091        RETURN
0092        END
```

```
      C
      C
      300   NR=-NR
            CALL BTIME(IDAY,IYR,IHR,IMIN,ISEC)
            WRITE(ICRT,302) NR,IHR,IMIN,ISEC
      302   FORMAT(' ENDING AT RECORD',I4,
           *     ', AT ',I2,':',I2,':',I2/)
            WRITE(LP,310)
      310   FORMAT(1H1)
            STOP
            END
```

MIDAS FORTRAN IV   STORAGE MAP

NAME	OFFSET	ATTRIBUTES		
X1	000006	REAL*4	ARRAY (8)	
X2	000046	REAL*4	ARRAY (8)	
H	000106	REAL*4	ARRAY (8)	
Q	000146	REAL*4	ARRAY (8)	
V1	000206	REAL*4	ARRAY (8,8)	VECTORED
V2	000606	REAL*4	ARRAY (8,8)	VECTORED
Y1	001206	REAL*4	ARRAY (16)	
Y2	001306	REAL*4	ARRAY (16)	
R1	001406	REAL*4	ARRAY (16)	
R2	001506	REAL*4	ARRAY (16)	
T1	001606	REAL*4	ARRAY (16,16)	VECTORED
T2	003606	REAL*4	ARRAY (16,16)	VECTORED
T3	005606	REAL*4	ARRAY (16)	
S1	005706	REAL*4	ARRAY (16,8)	VECTORED
S2	006706	REAL*4	ARRAY (16,8)	VECTORED
Q1	007706	REAL*4	ARRAY (8)	
Q2	007746	REAL*4	ARRAY (8)	
P1	010006	REAL*4	ARRAY (8)	
P2	010046	REAL*4	ARRAY (8)	
K	010106	INTEGER*2	VARIABLE	
IN	010110	INTEGER*2	VARIABLE	
IL	010112	INTEGER*2	VARIABLE	
IS	010114	INTEGER*2	VARIABLE	
IT	010116	INTEGER*2	VARIABLE	
NR	010120	INTEGER*2	VARIABLE	
ICRT	010122	INTEGER*2	VARIABLE	
LP	010124	INTEGER*2	VARIABLE	
INIT	010126	INTEGER*2	VARIABLE	
KLIN	000000	INTEGER*2	PROCEDURE	
NID	010442	INTEGER*2	VARIABLE	
M	010444	INTEGER*2	VARIABLE	
MS	010446	INTEGER*2	VARIABLE	
MF	010450	INTEGER*2	VARIABLE	
KINIT	000000	INTEGER*2	PROCEDURE	
N1	010452	INTEGER*2	VARIABLE	
N2	010454	INTEGER*2	VARIABLE	
BTIME	000000	REAL*4	PROCEDURE	
IDAY	010456	INTEGER*2	VARIABLE	
IYR	010460	INTEGER*2	VARIABLE	
IHR	010462	INTEGER*2	VARIABLE	
IMIN	010464	INTEGER*2	VARIABLE	
ISEC	010466	INTEGER*2	VARIABLE	
L	010470	INTEGER*2	VARIABLE	
KSTEP	000000	INTEGER*2	PROCEDURE	
DDKALM	000000	REAL*4	PROCEDURE	
IER	010472	INTEGER*2	VARIABLE	
J	010474	INTEGER*2	VARIABLE	
I	010476	INTEGER*2	VARIABLE	
KOUT	000000	INTEGER*2	PROCEDURE	
MOD	000000	INTEGER*2	PROCEDURE	

```
ND 6600 LINKER      V02-A-1      LOAD MAP    14 JAN 1985 11:35:15 AM

SECTION ADDR   SIZE   ENTRY  ADDR   ENTRY  ADDR   ENTRY  ADDR
. ABS.  000000 000000 $LRECL 000210 $NLCHN 000006 $USRSW 000000
                      $RF1B3 000000
. ABS.  000000 000000 $TRACE 004737
. ABS.  000000 000000 $V004A 000001
.$$$.&  020000 000000 .$$$.  020000
        020000 012522
        032522 005754 KINIT  032522
        040476 003762 KLIN   040476
        044460 002364 DDKALM 044460
        047044 007542 KOUT   047044
        056606 001326 KSTEP  056606
        060134 000372 LIBIN  060134
        060526 000452 VMULFF 060526
        061200 000436 VMULFP 061200
        061636 000362 LEQT1F 061636
        062220 003554 LUDATF 062220
        065774 000760 LUELMF 065774
        066754 002026 UERTST 066754
        071002 002106 FREEFM 071002
        073110 000146 XFF$   073110 $PWRR  073110
        073256 000060 NMI$II 073256 NMI$MI 073304 NMI$PI 073312
                      NPI$II 073322 NPI$MI 073326 NPI$PI 073332
        073336 000064 NMI$IP 073336 NMI$MP 073370 NMI$PP 073376
                      NPI$IP 073406 NPI$MP 073412 NPI$PP 073416
        073422 000044 NMI$1P 073422 NPI$1I 073442 NPI$1M 073454
                      NPI$1P 073436
        073466 000142 SQRT   073466
        073630 000350 EXP    073630
        074200 000360 ALOG   074204 ALOG10 074200
        074560 000262 XFI$   074560 $PWRI  074560
        075042 000040 MOD    075042
        075102 000110 TAD$   075132 TAF$   075140 TAI$   075102
                      TAL$   075110 TAP$   075124 TAQ$   075116
        075212 000020 STK$F  075222 STK$I  075216 STK$L  075212
        075232 000056 $OTIS  075232
        075310 000210 ISN$   075310 LSN$   075330 $ISNTR 075314
                      $LSNTR 075334
        075520 000034 END$   075520 ERR$   075536
        075554 000046 EOL$   075554
        075622 000066 DEO$   075622
        075710 000044 RET$   075724 RET$F  075714 RET$I  075722
                      RET$L  075710
        075754 001106 IBR$   075762 IBW$   075754 $IBW   075766
        077062 000072 ENC$   077062
        077154 000020 IFR$   077154 IFW$   077166
        077174 001562 $FIO   077662
        100756 002344 DCO$   102402 ECO$   102374 FCO$   102370
                      GCO$   102362 ICI$   100764 ICO$   102136
                      OCI$   100756 OCO$   102130 RCI$   101160
                      $GET   101144
        103322 000036 CFD$   103322 $DR    103322
```

```
103360 000110 $DUMPL 103360
103470 000036 $GETFI 103470
103526 000042 DII$IS 103540 DII$MS 103534 DII$PS 103526
              DII$SS 103542 $DVI   103542
103570 000040 MUI$IS 103602 MUI$MS 103576 MUI$PS 103570
              MUI$SS 103604 $MLI   103604
103630 000130 CIC$   103630 CID$   103630 CIF$   103640
              CIL$   103752 CLC$   103630 CLD$   103630
              CLF$   103640 CLI$   103756 $DI    103630
              $RI    103640
103760 000120 $FCHNL 103760
104100 000044 BEQ$   104120 BGE$   104130 BGT$   104126
              BLE$   104116 BLT$   104140 BNE$   104136
              BRA$   104132 NMI$1I 104110 NMI$1M 104100
104144 000002 $AOTS  104144
104146 000100 CCI$   104146 CDI$   104146 CFI$   104162
              $IC    104146 $ID    104146 $IR    104162
104246 000016 $FCALL 104246
104264 000012 $WAIT  104264
104276 000044 JMC$   104304 JMI$M  104300 JMI$P  104276
104342 000030 AND$   104346 EQV$   104354 IOR$   104342
              XOR$   104356
104372 000036 CAI$   104372 CAL$   104400
104430 000024 MAX0   104430
104454 000024 MIN0   104454
104500 000016 ABS    104500
104516 000016 MOI$RA 104530 MOI$RM 104522 MOI$RP 104526
              MOI$RS 104516 MOL$RS 104516
104534 000102 MOI$IA 104560 MOI$IM 104554 MOI$IS 104550
              MOI$MA 104574 MOI$MM 104570 MOI$MS 104564
              MOI$SA 104544 MOI$SM 104540 MOI$SS 104534
              MOI$0A 104610 MOI$0M 104604 MOI$0S 104600
              MOI$1A 104630 MOI$1M 104622 MOI$1S 104614
              MOL$IS 104550 MOL$SS 104534 REL$   104550
104636 000046 CMI$IP 104636 CMI$MP 104646 CMI$PI 104670
              CMI$PM 104676 CMI$PP 104656 CMI$PS 104662
              CMI$SP 104640
104704 000044 CMI$II 104724 CMI$IM 104730 CMI$IS 104720
              CMI$MI 104740 CMI$MM 104744 CMI$MS 104734
              CMI$SI 104710 CMI$SM 104714 CMI$SS 104704
104750 000016 NGI$A  104762 NGI$M  104754 NGI$P  104760
              NGI$S  104750
104766 000034 DCI$A  105016 DCI$M  105010 DCI$P  105014
              DCI$S  105004 ICI$A  105000 ICI$M  104772
              ICI$P  104776 ICI$S  104766
105022 000046 SUI$IP 105022 SUI$MP 105036 SUI$PA 105062
              SUI$PM 105054 SUI$PP 105032 SUI$PS 105046
              SUI$SP 105024
105070 000044 SUI$IA 105110 SUI$IM 105114 SUI$IS 105104
              SUI$MA 105124 SUI$MM 105130 SUI$MS 105120
              SUI$SA 105074 SUI$SM 105100 SUI$SS 105070
105134 000046 ADI$IP 105134 ADI$MP 105150 ADI$PA 105174
              ADI$PM 105166 ADI$PP 105144 ADI$PS 105160
              ADI$SP 105136
```

```
105202 000044 ADI$IA 105222 ADI$IM 105226 ADI$IS 105216
              ADI$MA 105236 ADI$MM 105242 ADI$MS 105232
              ADI$SA 105206 ADI$SM 105212 ADI$SS 105202
105246 000064 MOI$IP 105246 MOI$MP 105262 MOI$PA 105306
              MOI$PM 105300 MOI$PP 105256 MOI$PS 105272
              MOI$SP 105250 MOI$0P 105314 MOI$1P 105322
105332 000174 CMF$II 105406 CMF$IM 105470 CMF$IP 105440
              CMF$IS 105352 CMF$MI 105376 CMF$MM 105460
              CMF$MP 105430 CMF$MS 105336 CMF$PI 105372
              CMF$PM 105454 CMF$PP 105424 CMF$PS 105332
              CMF$SI 105412 CMF$SM 105474 CMF$SP 105444
              CMF$SS 105360 $CMR   105360
105526 000026 MOF$RA 105544 MOF$RM 105534 MOF$RP 105550
              MOF$RS 105526
105554 000012 MOF$SS 105554
105566 000014 MOF$IS 105566 MOF$0S 105574
105602 000016 MOF$MS 105602 MOF$PS 105614
105620 000014 MOF$SA 105620
105634 000010 MOF$IA 105634
105644 000014 MOF$SM 105644 MOF$SP 105654
105660 000020 MOF$IM 105660 MOF$IP 105672
105700 000020 MOF$0A 105710 MOF$0M 105700 MOF$0P 105714
105720 000042 MOF$MA 105732 MOF$MM 105720 MOF$MP 105740
              MOF$PA 105752 MOF$PM 105746 MOF$PP 105756
105762 000054 SAI$PM 105762 SAI$PP 106010 SVI$PM 105774
              SVI$PP 106022
106036 000032 SAI$IP 106036 SAI$MP 106060 SAI$SP 106040
              SVI$IP 106046 SVI$MP 106064 SVI$SP 106050
106070 000032 SAI$IM 106070 SAI$MM 106112 SAI$SM 106072
              SVI$IM 106100 SVI$MM 106116 SVI$SM 106102
106122 000032 TSD$I  106142 TSD$M  106136 TSD$P  106146
              TSD$S  106126 TSF$I  106142 TSF$M  106136
              TSF$P  106146 TSF$S  106132 TSI$I  106142
              TSI$M  106136 TSI$P  106146 TSI$S  106122
106154 000034 CPD$SM 106176 CPF$SM 106164 CPI$SM 106160
              CPL$SM 106154
106210 000030 LEQ$   106212 LGE$   106222 LGT$   106220
              LLE$   106210 LLT$   106234 LNE$   106232
106240 000024 TSL$I  106250 TSL$M  106244 TSL$P  106256
              TSL$S  106240
106264 000044 SAF$IP 106264 SAF$MP 106320 SAF$SP 106266
              SVF$IP 106276 SVF$MP 106324 SVF$SP 106300
106330 000044 SAF$IM 106330 SAF$MM 106364 SAF$SM 106332
              SVF$IM 106342 SVF$MM 106370 SVF$SM 106344
106374 000036 NGD$A  106426 NGD$M  106406 NGD$P  106422
              NGD$S  106374 NGF$A  106426 NGF$M  106406
              NGF$P  106422 NGF$S  106374
106432 000030 MOD$MS 106442 MOD$PS 106436 MOD$SS 106432
              MOD$VS 106444
106462 000046 MOD$MA 106512 MOD$MM 106500 MOD$MP 106466
              MOD$PA 106506 MOD$PM 106474 MOD$PP 106462
106530 000020 MOD$SM 106534 MOD$SP 106530
106550 000044 SAD$IM 106550 SAD$MM 106604 SAD$SM 106552
              SVD$IM 106564 SVD$MM 106610 SVD$SM 106566
```

```
         106614 000016 CCF$    106614 CDF$    106614 $RC     106614
                       $RD     106614
         106632 001166 ADD$IS  106702 ADD$MS  106662 ADD$PS  106656
                       ADD$SS  106730 SUD$IS  106714 SUD$MS  106636
                       SUD$PS  106632 SUD$SS  106724 $ADD    106730
                       $SBD    106724
         110020 000074 SAD$PM  110020 SAD$PP  110056 SVD$PM  110036
                       SVD$PP  110074
ARRAY  & 110114 004000 ARRAY   110114
ARRAY  & 110114 004000
HEAD   & 114114 000200 HEAD    114114
HEAD   & 114114 000200
DATA   & 114314 000240 DATA    114314
DATA   & 114314 000240
DATA   & 114314 000240
FREE   & 114554 000340 FREE    114554
FREE   & 114554 000340
FREE   & 114554 000340
HDR    & 115114 000024 HDR     115114
HDR    & 115114 000024
IQ     & 115140 000004 IQ      115140
IQ     & 115140 000004
IQ     & 115140 000004
ATIME$   115144 000100 ATIME   115144
BTIME$   115244 000100 BTIME   115244
MCLI$    115344 000632 MCLI    115344
$M.TVT   116176 000062 TVD$    116212 TVF$    116204 TVI$    116234
                       TVL$    116176 TVP$    116226 TVQ$    116220
OT       116260 001510 $ERR$$  116770 $FPERR  116632 $OTI    116260
STOP     117770 000112 EXIT    120014 FOO$    117770 STP$    120014
RIO      120102 000600 DEF$    120616 IRR$    120102 IRW$    120106
                       $GETIN  120466
GETREC   120702 000346 $GETRE  120702 $TTYIN  121202
ENDFIL   121250 000042 EOF$    121250
CLOSS    121312 000550 $CLOSE  121312
$M.RMM   122062 000170 AMAX1   122104 AMIN1   122062 MAX1    122072
                       MIN1    122066
OUTREC   122252 000414 $PUTRE  122252
$M.FIO   122666 000216 $FMTDR  122666 $FMTDW  122722 $INITI  122774
OPEN     123104 000610 $OPEN   123104
FADD     123714 000062 ADF$IS  123714 ADF$MS  123726 ADF$PS  123722
                       ADF$SS  123720 SUF$IS  123742 SUF$MS  123754
                       SUF$PS  123750 SUF$SS  123746 $ADR    123720
                       $SBR    123746
FDIV     123776 000034 DIF$IS  124014 DIF$MS  124002 DIF$PS  123776
                       DIF$SS  124020 $DVR    124020
FMUL     124032 000034 MUF$IS  124050 MUF$MS  124036 MUF$PS  124032
                       MUF$SS  124054 $MLR    124054
RWBLK    124066 000460 $EOFIL  124476 $GETBL  124310 $PUTBL  124065
ERRTB    124546 000100 $ERRTB  124546
ERRS     124646 002570 $ERRS   124646
$M.LCV   127436 000106 LCI$    127436 LCO$    127504
ADDM     127544 000116 ADF$IM  127544 ADF$MM  127556 ADF$PM  127552
                       ADF$SM  127566 SUF$IM  127602 SUF$MM  127636
```

```
                        SUF$PM 127632 SUF$SM 127610
ADDP      127662 000114 ADF$IP 127662 ADF$MP 127674 ADF$PP 127570
                        ADF$SP 127704 SUF$IP 127720 SUF$MP 127754
                        SUF$PP 127750 SUF$SP 127726
ADDA      127776 000150 ADF$IA 127776 ADF$MA 130030 ADF$PA 130024
                        ADF$SA 130006 SUF$IA 130054 SUF$MA 130110
                        SUF$PA 130104 SUF$SA 130062 $FPAR  130050
                        $FPSR  130130


SEGMENT PARAMETER TABLE

SEG  SIZE   LIMIT
 0  110146 130146

PROGRAM SIZE = 110146
DATA AREA SIZE = 000000
TRANSFER ADDRESS = 020000
STACK SIZE = 001000
```

```
      SUBROUTINE KINIT(X1,X2,Y1,Y2,H,V1,V2,P1,P2,Q1,Q2,
     1    S1,S2,N1,N2,M,MS,MF)
C     INITIALIZES KALMAN FILTER FOR NIAGARA DATA
C     LAST MODIFIED BY G.W.PHILLIPS, MARCH 1982
C
      COMMON/ARRAY/ARRAY(512)
      COMMON/HEAD/HDR1(8),HDR2(8)
      REAL*8 HDR1,HDR2
      REAL*4 X1(8),X2(8),Y1(16),Y2(16),S1(16,8),S2(16,8)
      REAL*4 P1(8),P2(8),Q1(8),Q2(8),H(8),V1(8,8),V2(8,8)
      INTEGER CRT,DATA,PERIOD,BLANK,COMMA
      COMMON/DATA/DATA(80)/FREE/INTEG(16),REALX(16),ALPHA(16)
      REAL*8 FILDEF(5),ALPHA,ABLANK
      DATA FILDEF/8H@DEF 8  ,1H ,1H.,1H ,1H@/,ABLANK/8H        /
      DATA CRT/5/,LP/6/,IN/5/,IOUT/6/,PERIOD/1H./,BLANK/1H /
      DATA COMMA/1H,/,LUF/8/
```

```
      C
0013  100   N1=0
0014        WRITE(CRT,110)
0015  110   FORMAT(1H0,'INPUT POD 1 LIBRARY SPECTRA'/
           1     1X,'FILENAME,COUNT TIME,REL. INTENS.(,FRACT. ERROR)'/
           2     1X,'TERMINATE WITH (CR)')
0016        WRITE(IOUT,112)
0017  112   FORMAT(1H0,'POD 1 LIBRARY')
0018  120   N1=N1+1
0019        WRITE(CRT,130)N1
0020  130   FORMAT(1X,I3,$)
0021        READ(CRT,140)LEN,DATA
0022  140   FORMAT(Q,80A1)
0023        IF(LEN.LT.1) GOTO 190
0025        WRITE(IOUT,142) N1,(DATA(I),I=1,LEN)
0026  142   FORMAT(1H0,I5,2X,80A1)
0027        DO 150 I=1,LEN
0028        IF(DATA(I).EQ.COMMA) GOTO 152
0030        IF(DATA(I).EQ.PERIOD) DATA(I)=BLANK
0032  150   CONTINUE
0033  152   NX=2
0034        MX=1
0035        NA=1
0036        CALL FREEFM(NX,MX,NA,3)
0037        FILDEF(2)=ALPHA(1)
0038        FILDEF(4)=ALPHA(2)
0039        HDR1(N1)=ALPHA(2)
0040        IF(NX.EQ.2) GOTO 153
0042        HDR1(N1)=ALPHA(1)
0043        FILDEF(4)=ABLANK
0044  153   CALL MCLI(FILDEF)
0045        NX=3
0046        MX=1
0047        CALL FREEFM(NX,MX,NA,2)
0048        FX=10./REALX(1)
0049        X1(N1)=REALX(2)
0050        P1(N1)=1
0051        IF(NX.EQ.3) P1(N1)=REALX(3)**2
      C
```

```
C
          MI=256
          CALL LISIN(LUF,MI)
D         WRITE(LP,155)N1,(ARRAY(I),I=1,MI)
D155      FORMAT(' POD 1, LIBRARY MEMBER',I3/(10G13.3))
          IF(MI.GE.MF) GOTO 160
          WRITE(CRT,156) N1,MI
  156     FORMAT(1X,'LIBRARY MEMBER',I4,' SHORT, LENGTH=',I4/)
  160     ML=(MF-MS+M)/M
D         WRITE(CRT,162) M,MS,MF,ML
D162      FORMAT(1H0,'M,MS,MF,ML=',4(I4,','))
          Q1(N1)=0.
          IJ=0
          DO 180 J=MS,MF,ML
          MJ=J+ML-1
          IF(MJ.GT.MF) MJ=MF
          SUM=0.
          DO 170 I=J,MJ
  170     SUM=SUM+ARRAY(I)
          SUM=FX*SUM
          IJ=IJ+1
          S1(IJ,N1)=SUM
          Q1(N1)=Q1(N1)+SUM
  180     CONTINUE
          WRITE(IOUT,182) (S1(I,N1),I=1,M)
  182     FORMAT(1H0,'CONDENSED SPECTRUM',8G13.3/(19X,8G13.3))
          GOTO 120
C
  190     N1=N1-1
          WRITE(IOUT,192) (Q1(I),I=1,N1)
  192     FORMAT(1H0,'GRANDSUMS:',8G13.3/(10X,8G13.3))
C
```

```
      C
      200   N2=0
            WRITE(CRT,210)
      210   FORMAT(1H0,'INPUT POD 2 LIBRARY SPECTRA'/
          1     1X,'FILENAME,COUNT TIME,REL. INTENS.(,FRACT. ERROR)'/
          2     1X,'TERMINATE WITH (CR)')
            WRITE(IOUT,213)
      213   FORMAT(1H0,'POD 2 LIBRARY')
      220   N2=N2+1
            WRITE(CRT,230)N2
      230   FORMAT(1X,I3,$)
            READ(CRT,240)LEN,DATA
      240   FORMAT(Q,80A1)
            IF(LEN.LT.1) GOTO 290
            WRITE(IOUT,242) N2,(DATA(I),I=1,LEN)
      242   FORMAT(1H0,I5,2X,80A1)
            DO 250 I=1,LEN
            IF(DATA(I).EQ.COMMA) GOTO 252
            IF(DATA(I).EQ.PERIOD) DATA(I)=BLANK
      250   CONTINUE
      252   NX=2
            MX=1
            NA=1
            CALL FREEFM(NX,MX,NA,3)
            FILDEF(2)=ALPHA(1)
            FILDEF(4)=ALPHA(2)
            HDR2(N2)=ALPHA(2)
            IF(NX.EQ.2) GOTO 253
            HDR2(N2)=ALPHA(1)
            FILDEF(4)=ABLANK
      253   CALL MCLI(FILDEF)
            NX=3
            MX=1
            CALL FREEFM(NX,MX,NA,2)
            FX=10./REALX(1)
            X2(N2)=REALX(2)
            P2(N2)=1.
            IF(NX.EQ.3) P2(N2)=REALX(3)**2
```

```
      C
      C
            MI=256
            CALL LIBIN(LUF,MI)
      D     WRITE(LP,255)N2,(ARRAY(I),I=1,MI)
      D255  FORMAT(' POD 2, LIBRARY MEMBER',I3/(10G13.3))
            IF(MI.GE.MF) GOTO 260
            WRITE(CRT,256) N2,MI
      256   FORMAT(1X,'LIBRARY MEMBER',I4,' SHORT, LENGTH=',I4/)
      260   ML=(MF-MS+M)/M
      D     WRITE(CRT,262) M,MS,MF,ML
      D262  FORMAT(1H0,'M,MS,MF,ML=',4(I4,','))
            Q2(N2)=0.
            IJ=0
            DO 280 J=MS,MF,ML
            MJ=J+ML-1
            IF(MJ.GT.MF) MJ=MF
            SUM=0.
            DO 270 I=J,MJ
      270   SUM=SUM+ARRAY(I)
            SUM=FX*SUM
            IJ=IJ+1
            S2(IJ,N2)=SUM
            Q2(N2)=Q2(N2)+SUM
      280   CONTINUE
            WRITE(IOUT,282)(S2(I,N2),I=1,M)
      282   FORMAT(1H0,'CONDENSED SPECTRUM',8G13.3/(19X,8G13.3))
            GOTO 220
      C
      290   N2=N2-1
            WRITE(IOUT,292) (Q2(I),I=1,N2)
      292   FORMAT(1H0,'GRANDSUMS',8G13.3/(10X,8G13.3))
      C
```

```
      C
      300   SUMY1=0.
            SUMY2=0.
            DO 320 J=1,M
            SUMY1=SUMY1+Y1(J)
            SUMY2=SUMY2+Y2(J)
      320   CONTINUE
            SUMX1=0.
            DO 340 I=1,N1
      340   SUMX1=SUMX1+X1(I)*Q1(I)
      D     WRITE(CRT,341)SUMY1,SUMX1,(I,X1(I),Q1(I),I=1,N1)
      D341  FORMAT(' POD1: SUMY=',G13.3,', GRANDSUMX=',G13.3/
      D    1     (I10,2G13.3))
            XNORM1=SUMY1/SUMX1
            SUMX2=0.
            DO 360 I=1,N2
      360   SUMX2=SUMX2+X2(I)*Q2(I)
      D     WRITE(CRT,361)SUMY2,SUMX2,(I,X2(I),Q2(I),I=1,N2)
      D361  FORMAT(' POD2* SUMY=',G13.3,', GRANDSUMX=',G13.3/
      D    1     (I10,2G13.3))
            XNORM2=SUMY2/SUMX2
```

```
C
C
400     DO 420 I=1.N1
        X1(I)=X1(I)*XNORM1
        O1(I)=P1(I)
        P1(I)=P1(I)*X1(I)**2
        V1(I.I)=P1(I)
420     CONTINUE
        DO 440 I=1.N2
        X2(I)=X2(I)*XNORM2
        O2(I)=P2(I)
        P2(I)=P2(I)*X2(I)**2
        V2(I.I)=P2(I)
440     CONTINUE
        WRITE(IOUT,442)(X1(I),I=1,N1)
442     FORMAT(1H0,'INITIAL INPUT VECTORS'/
       1    1X,'POD 1',8G13.3/(7X,8G13.3))
        WRITE(IOUT,444)(X2(I),I=1,N2)
444     FORMAT(1X,'POD 2',8G13.3/(7X,8G13.3))
C
        N=MAX0(N1,N2)
        DO 480 I=1,N
        H(I)=1.
480     CONTINUE
C
500     RETURN
        END
```

ᴵE (Binary Time) Subroutine

BTIME subroutine is used to return to the user the binary time. This ·outine is written in Assembler.

n

_ BTIME (a,b,c,d,e)

re:

Integer to receive the Julian date.

Integer to receive the year.

Integer to receive the hour.

Integer to receive the minutes.

Integer to receive the seconds.

e

the parameter count is <5 or >5, then an exit is made to MIDAS.

mple

```
'EGER A,B,C,D,E


.L BTIME (A,B,C,D,E)
```

Appendix C: MIDAS System Utilities

1. BTIME
2. MCLI
3. MTAPEF
4. DANDC

LF	[illegible]226	INTEGER*2	VARIABLE
IBLANK	001230	INTEGER*2	VARIABLE
ISTAR	001232	INTEGER*2	VARIABLE
[illegible]	[illegible]	REAL*4	PROCEDURE
[illegible]	[illegible]	REAL*4	VARIABLE
[illegible]	[illegible]	REAL*4	PROCEDURE
[illegible]	[illegible]	REAL*4	PROCEDURE
[illegible]	[illegible]	REAL*4	VARIABLE
[illegible]	000000	REAL*4	PROCEDURE
[illegible]	[illegible]	REAL*4	VARIABLE
AL3	[illegible]	REAL*4	VARIABLE
AL5	[illegible]	REAL*4	VARIABLE
SQR3	002406	REAL*4	VARIABLE
SQR5	002412	REAL*4	VARIABLE
NM1	002416	INTEGER*2	VARIABLE
I	002420	INTEGER*2	VARIABLE
SIG	002422	REAL*4	VARIABLE
SIG3	002426	REAL*4	VARIABLE
SIG5	002432	REAL*4	VARIABLE
NM2	002436	INTEGER*2	VARIABLE
U1	002440	REAL*4	VARIABLE
U2	002444	REAL*4	VARIABLE
CHU1	002450	REAL*4	VARIABLE
J	002454	INTEGER*2	VARIABLE
AMAX1	000000	REAL*4	PROCEDURE
ICHFL1	002456	INTEGER*2	VARIABLE
XCH1	002460	REAL*4	VARIABLE
CHU2	002464	REAL*4	VARIABLE
ICHFL2	002470	INTEGER*2	VARIABLE
XCH2	002472	REAL*4	VARIABLE
ATIME	000000	REAL*4	PROCEDURE
NU1	002476	INTEGER*2	VARIABLE
NU2	002500	INTEGER*2	VARIABLE

COMMON BLOCK /HEAD/ LENGTH 000200

HDR1	000000	REAL*8	ARRAY (8)
HDR2	000100	REAL*8	ARRAY (8)

COMMON BLOCK /HDR/ LENGTH 000024

HEADER	000000	INTEGER*2	ARRAY (10)

COMMON BLOCK /IQ/ LENGTH 000004

IQ1	000000	INTEGER*2	VARIABLE
IQ2	000002	INTEGER*2	VARIABLE

```
FORTRAN IV    STORAGE MAP

NAME      OFFSET   ATTRIBUTES

KDATE     000064   INTEGER*2 ARRAY (12)
X1        000022   REAL*4    PARAMETER ARRAY (8)
X2        000024   REAL*4    PARAMETER ARRAY (8)
P1        000026   REAL*4    PARAMETER ARRAY (8)
P2        000030   REAL*4    PARAMETER ARRAY (8)
Q1        000042   REAL*4    PARAMETER ARRAY (8)
Q2        000044   REAL*4    PARAMETER ARRAY (8)
Y1        000032   REAL*4    PARAMETER ARRAY (16)
Y2        000034   REAL*4    PARAMETER ARRAY (16)
R1        000046   REAL*4    PARAMETER ARRAY (16)
R2        000050   REAL*4    PARAMETER ARRAY (16)
S1        000036   REAL*4    PARAMETER ARRAY (16,8) VECTORED
S2        000040   REAL*4    PARAMETER ARRAY (16,8) VECTORED
A1X       000114   REAL*4    ARRAY (8)
A1SQ      000154   REAL*4    ARRAY (8)
A13       000214   REAL*4    ARRAY (8)
A15       000254   REAL*4    ARRAY (8)
A2X       000314   REAL*4    ARRAY (8)
A2SQ      000354   REAL*4    ARRAY (8)
A23       000414   REAL*4    ARRAY (8)
A25       000454   REAL*4    ARRAY (8)
XNM1      000514   REAL*4    ARRAY (8)
XNM2      000554   REAL*4    ARRAY (8)
VAR1      000614   REAL*4    ARRAY (8)
VAR2      000654   REAL*4    ARRAY (8)
XN1       000714   REAL*4    ARRAY (8)
XN2       000754   REAL*4    ARRAY (8)
SIG1      001014   REAL*4    ARRAY (8)
SIG2      001054   REAL*4    ARRAY (8)
J1FLAG    001114   INTEGER*2 ARRAY (8)
J2FLAG    001134   INTEGER*2 ARRAY (8)
IHEAD     001154   INTEGER*2 ARRAY (6)
AHEAD     001154   REAL*8    ARRAY (2)
K         000014   INTEGER*2 PARAMETER VARIABLE
NR        000016   INTEGER*2 PARAMETER VARIABLE
NID       000020   INTEGER*2 PARAMETER VARIABLE
N1        000052   INTEGER*2 PARAMETER VARIABLE
N2        000054   INTEGER*2 PARAMETER VARIABLE
M         000056   INTEGER*2 PARAMETER VARIABLE
MS        000060   INTEGER*2 PARAMETER VARIABLE
MF        000062   INTEGER*2 PARAMETER VARIABLE
AMX       001174   REAL*4    VARIABLE
AM3       001200   REAL*4    VARIABLE
AM5       001204   REAL*4    VARIABLE
MNM       001210   INTEGER*2 VARIABLE
THRESH    001212   REAL*4    VARIABLE
THSIG     001216   REAL*4    VARIABLE
I1        001222   INTEGER*2 VARIABLE
I2        001224   INTEGER*2 VARIABLE
```

```
      C
0136  400   CONTINUE
      D     WRITE(LP,360)IHEAD,(HDR1(I),I=1,N1),(HDR2(I),I=1,N2)
0137        IF(N1+N2.GT.10) GOTO 420
0139        WRITE(LP,410)NR,NID,XCH1,ICHFL1,XCH2,ICHFL2,
          1                (X1(I),J1FLAG(I),I=1,N1),(X2(I),J2FLAG(I),I=1,N2)
0140  410   FORMAT(I5,I4,1X,2(F5.2,A1),10(1PG10.3,A1))
0141        WRITE(3,412) NR,NID,(XN1(I),I=1,N1),(XN2(I),I=1,N2)
0142  412   FORMAT(1X,2I5,1X,(10(1PG11.3)))
      D     WRITE(3,414) (A1X(I),I=1,N1),(A2X(I),I=1,N2)
      D     WRITE(3,414) (VAR1(I),I=1,N1),(VAR2(I),I=1,N2)
      D414  FORMAT(12X,10(1PG11.3))
0143        GOTO 500
      C
0144  420   WRITE(LP,440)NR,NID,XCH1,ICHFL1,XCH2,ICHFL2,
          1                (X1(I),J1FLAG(I),I=1,N1),(X2(I),J2FLAG(I),I=1,N2)
0145  440   FORMAT(I5,I4,1X,2(F5.2,A1),10(1PG10.3,A1)/
          1                (16X,10(G10.3,A1)))
0146        WRITE(3,442) NR,NID,(XN1(I),I=1,N1),(XN2(I),I=1,N2)
0147  442   FORMAT(1X,2I5,1X,10(1PG11.3)/(6X,10(G11.3)))
      D     WRITE(3,444) (A1X(I),I=1,N1),(A2X(I),I=1,N2)
      D     WRITE(3,444) (VAR1(I),I=1,N1),(VAR2(I),I=1,N2)
      D444  FORMAT(12X,10(1PG11.3)/(6X,10(1PG11.3)))
      C
0148  500   RETURN
0149        END
```

```
      C
      200   U1=M-N1
            U2=M-N2
            CHU1=0.
            DO 210 J=1,M
      210   CHU1=CHU1+R1(J)**2/AMAX1(Y1(J),1.)
            CHU1=CHU1/U1
            ICHFL1=IBLANK
            XCH1=FXCH(CHU1,U1)
            IF(XCH1.GT.THRESH) ICHFL1=ISTAR
            CHU2=0.
            DO 220 J=1,M
      220   CHU2=CHU2+R2(J)**2/AMAX1(Y2(J),1.)
            CHU2=CHU2/U2
            ICHFL2=IBLANK
            XCH2=FXCH(CHU2,U2)
            IF(XCH2.GT.THRESH) ICHFL2=ISTAR
      C
      300   IF(K.GT.1) GOTO 400
            CALL ATIME(KDATE)
            WRITE(LP,305) (HEADER(I),I=1,7),KDATE
      305   FORMAT(1H1,2X,7A2,3X,'PROCESSED ON ',12A2)
            WRITE(LP,310) MS,MF,M,THRESH,IQ1,IQ2
      310   FORMAT(1H0,'OUTPUT FOR KALMAN FILTER'/
           1    1X,'USING DATA FROM CHANNEL',I4,' TO',I4/
           2    1X,'CONDENSED TO',I3,' OUTPUT VECTOR CHANNELS'/
           3    1X,'THRESHOLD IS',G13.3/
           4    1X,'FINAL LEARNING RECORDS,',I5,' FOR POD 1,',
           5    I5,' FOR POD 2')
            NU1=M-N1
            NU2=M-N2
            WRITE(LP,320)I1,N1,NU1
            WRITE(LP,320)I2,N2,NU2
      320   FORMAT(1X,'INPUT VECTOR FOR POD',I1,' HAS',I3,
           1    ' VARIABLE INTENSITIES. LEAVING',I3,' DEGREES OF FREEDOM')
            WRITE(LP,360)IHEAD,(HDR1(I),I=1,N1),
           1                (HDR2(I),I=1,N2)
      360   FORMAT('0REC. MODE',1X,6A2,9(A8,3X),A8/
           1                (17X,10(A8,3X)))
            WRITE(3,370) (HEADER(I),I=1,7),KDATE
      370   FORMAT(1X,7A2,2X,12A2)
            WRITE(3,380) (HDR1(I),I=1,N1),(HDR2(I),I=1,N2)
      380   FORMAT('0 REC. MODE',3X,9(A8,3X),A8/
           1    (7X,10(A8,3X)))
```

```
      C
      C
0069        IF(K.GT.1) NM2=MNM
0071        IF(NR.GT.IQ2) NM2=1
0073        DO 140 I=1,N2
0074        A2X(I)=(A2X(I)*ALX+X2(I))/AMX
0075        A2SQ(I)=(A2SQ(I)*ALX+X2(I)**2)/AMX
0076        A23(I)=(A23(I)*AL3+X2(I))/AM3
0077        A25(I)=(A25(I)*AL5+X2(I))/AM5
0078        VAR2(I)=A2SQ(I)-A2X(I)**2
0079        IF(K.EQ.1) VAR2(I)=Q2(I)*X2(I)**2
0081        SIG=SQRT(VAR2(I))
0082        IF(NM2.EQ.0) SIG2(I)=SIG
0084        IF(NM2.EQ.0) XNM2(I)=A2X(I)
0086        IF(SIG2(I).GT.1.E-20) XN2(I)=(X2(I)-XNM2(I))/SIG2(I)
0088        SIG3=SIG/SQR3
0089        SIG5=SIG/SQR5
0090        J2FLAG(I)=IBLANK
0091        IF(XN2(I).GT.THSIG) J2FLAG(I)=ISTAR
0093        IF(X2(I)-A2X(I).GT.THSIG*SIG) J2FLAG(I)=ISTAR
0095        IF(A23(I)-A2X(I).GT.THSIG*SIG3) J2FLAG(I)=ISTAR
0097        IF(A25(I)-A2X(I).GT.THSIG*SIG5) J2FLAG(I)=ISTAR
0099  140   CONTINUE
```

```
C
100   ALX=.95*AMX
      AMX=ALX+1.
      AL3=.666667*AM3
      AM3=AL3+1.
      AL5=.8*AM5
      AM5=AL5+1.
      SQR3=SQRT(3.)
      SQR5=SQRT(5.)
      IF(NID.EQ.2.OR.NID.EQ.3) MNM=1
      IF(NID.GT.10.AND.NID.LT.100) MNM=1
      IF(K.GT.1) NM1=MNM
      IF(NR.GT.IQ1) NM1=1
      DO 120 I=1,N1
      A1X(I)=(A1X(I)*ALX+X1(I))/AMX
      A1SQ(I)=(A1SQ(I)*ALX+X1(I)**2)/AMX
      A13(I)=(A13(I)*AL3+X1(I))/AM3
      A15(I)=(A15(I)*AL5+X1(I))/AM5
      VAR1(I)=A1SQ(I)-A1X(I)**2
      IF(K.EQ.1) VAR1(I)=Q1(I)*X1(I)**2
      SIG=SQRT(VAR1(I))
      IF(NM1.EQ.0) SIG1(I)=SIG
      IF(NM1.EQ.0) XNM1(I)=A1X(I)
      IF(SIG1(I).GT.1.E-20) XN1(I)=(X1(I)-XNM1(I))/SIG1(I)
      SIG3=SIG/SQR3
      SIG5=SIG/SQR5
      J1FLAG(I)=IBLANK
      IF(XN1(I).GT.THSIG) J1FLAG(I)=ISTAR
      IF(X1(I)-A1X(I).GT.THSIG*SIG) J1FLAG(I)=ISTAR
      IF(A13(I)-A1X(I).GT.THSIG*SIG3) J1FLAG(I)=ISTAR
      IF(A15(I)-A1X(I).GT.THSIG*SIG5) J1FLAG(I)=ISTAR
120   CONTINUE
```

```
      SUBROUTINE KOUT(K,NR,NID,X1,X2,P1,P2,Y1,Y2,S1,S2,
     1    Q1,Q2,R1,R2,N1,N2,M,MS,MF)
C     OUTPUT PROGRAM FOR THE KALMAN FILTER
C     LAST MODIFIED BY G.W.PHILLIPS, JANUARY 1985
C
      COMMON/HEAD/HDR1(8),HDR2(8)
      COMMON/HDR/HEADER(10)
      COMMON/IQ/IQ1,IQ2
      INTEGER HEADER,KDATE(12)
      REAL*8 HDR1,HDR2
      REAL*4 X1(8),X2(8),P1(8),P2(8),Q1(8),Q2(8)
      REAL*4 Y1(16),Y2(16),R1(16),R2(16),S1(16,8),S2(16,8)
      REAL*4 A1X(8),A1SQ(8),A13(8),A15(8)
      REAL*4 A2X(8),A2SQ(8),A23(8),A25(8),XNM1(8),XNM2(8)
      REAL*4 VAR1(8),VAR2(8),XN1(8),XN2(8),SIG1(8),SIG2(8)
      INTEGER J1FLAG(8),J2FLAG(8),IHEAD(6)
      DATA A1X/8*0./,A1SQ/8*0./,A13/8*0./,A15/8*0./
      DATA A2X/8*0./,A2SQ/8*0./,A23/8*0./,A25/8*0./
      DATA XN1/8*0./,XN2/8*0./,SIG1/8*0./,SIG2/8*0./
      DATA XNM1/8*0./,XNM2/8*0./
      DATA AMX/0./,AM3/0./,AM5/0./,MNM/0/
      DATA THRESH/3.0/,THSIG/2.0/,I1/1/,I2/2/
      DATA LP/6/,IBLANK/1H /,ISTAR/1H*/
      REAL*8 AHEAD(2)
      DATA AHEAD/8HXSQ1  XS,8HQ2      /
      EQUIVALENCE (IHEAD,AHEAD)
C
      CBRT(U)=U**.3333333
      TW9(U)=2./(9.*U)
      FXCH(CHU,U)=(CBRT(CHU)-(1.-TW9(U)))/SQRT(TW9(U))
C
D     WRITE(LP,20) I1,(Y1(I),I=1,M)
D20   FORMAT(1H0,'POD', I2,': OBSERVED VECTOR=',8G13.3/(6X8G13.3))
D     WRITE(LP,40) (R1(I),I=1,M)
D40   FORMAT(1X,'RESIDUALS=',8G13.3/(6X,8G13.3))
D     WRITE(LP,60) (X1(I),P1(I),I=1,N1)
D60   FORMAT(1X,'X,P=',4(G13.3,',',G9.3)/(6X,4(G13.3,',',G9.3)))
D     WRITE(LP,20)I2,(Y2(I),I=1,M)
D     WRITE(LP,40) (R2(I),I=1,M)
D     WRITE(LP,60) (X2(I),P2(I),I=1,N2)
```

```
MIDAS FORTRAN IV   STORAGE MAP

NAME     OFFSET  ATTRIBUTES

X        000016  REAL*4    PARAMETER ARRAY (8)
Y        000020  REAL*4    PARAMETER ARRAY (16)
S        000022  REAL*4    PARAMETER ARRAY (16,8) VECTORED
Q        000024  REAL*4    PARAMETER ARRAY (8)
R        000030  REAL*4    PARAMETER ARRAY (16)
QQ       000026  REAL*4    PARAMETER ARRAY (8)
A1       000040  REAL*4    ARRAY (8)
A2       000100  REAL*4    ARRAY (8)
K        000014  INTEGER*2 PARAMETER VARIABLE
N        000032  INTEGER*2 PARAMETER VARIABLE
M        000034  INTEGER*2 PARAMETER VARIABLE
NR       000036  INTEGER*2 PARAMETER VARIABLE
IA       000140  INTEGER*2 VARIABLE
ICRT     000142  INTEGER*2 VARIABLE
A        000144  REAL*4    VARIABLE
B        000150  REAL*4    VARIABLE
I        000232  INTEGER*2 VARIABLE
AMAX1    000000  REAL*4    PROCEDURE
EPS      000234  REAL*4    VARIABLE
J        000240  INTEGER*2 VARIABLE
MOD      000000  INTEGER*2 PROCEDURE

COMMON BLOCK /IQ/        LENGTH 000004

IQ1      000000  INTEGER*2 VARIABLE
IQ2      000002  INTEGER*2 VARIABLE
```

```
0001           SUBROUTINE KSTEP(K,X,Y,S,Q,QO,R,N,M,NR)
      C        SETS UP NOISE VARIANCES FOR NEXT STEP IN KALMAN FILTER
      C        LAST MODIFIED BY G.W.PHILLIPS, APRIL 1982
      C
0002           REAL*4 X(8),Y(16),S(16,8),Q(8),R(16),QO(8)
0003           REAL*4 A1(8),A2(8)
0004           DATA A1/8*0./,A2/8*0./
0005           DATA IA/0/,ICRT/5/
0006           DATA A/0.2/,B/0.8/
0007           COMMON/IQ/IQ1,IQ2
      C
0008  100      DO 120 I=1,N
0009           Q(I)=X(I)**2*QO(I)
0010           Q(I)=AMAX1(Q(I),EPS)
0011  120      CONTINUE
0012           DO 140 J=1,M
0013  140      R(J)=AMAX1(Y(J),1.)
      C
      C        CALCULATE RUNNING AVERAGES OF Q(I)
      C        FOR EACH OF TWO PODS
      C
0014  200      IA=IA+1
0015           IF(MOD(IA,2).EQ.0) GOTO 250
0017           IF(NR.GT.IQ1) GOTO 230
0019           DO 220 I=1,N
0020  220      A1(I)=A*Q(I)+B*A1(I)
0021  230      DO 240 I=1,N
0022  240      Q(I)=AMAX1(Q(I),A1(I))
      D        GOTO 280
0023           RETURN
      C
0024  250      IF(NR.GT.IQ2) GOTO 270
0026           DO 260 I=1,N
0027  260      A2(I)=A*Q(I)+B*A2(I)
0028  270      DO 275 I=1,N
0029  275      Q(I)=AMAX1(Q(I),A2(I))
      D        GOTO 282
0030           RETURN
      C
0031  280      WRITE(ICRT,284) IA,(A1(I),I=1,N)
0032           GOTO 290
0033  282      WRITE(ICRT,284) IA,(A2(I),I=1,N)
0034  284      FORMAT(I5,8(1PG10.3))
      C
0035  290      WRITE(ICRT,292) (Q(I),I=1,N)
0036  292      FORMAT(5X,8(1PG10.3))
0037           RETURN
0038           END
```

```
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            SUBROUTINE LIBIN(LUF,M)
C           READS DATA FROM ND SPECTRAL DATA FILES
C           WRITTEN BY G.PHILLIPS, JULY 1981
C
            COMMON/ARRAY/ARRAY(512)
C
            DEFINE FILE LUF(0,2,U,IVAR)
            IVAR=193
            DO 100 K=1,M
            READ(LUF'IVAR,END=200)MSB,LSB
            RE1=MSB
            RE2=LSB
            IF(RE2.LT.0.)RE2=65536.+RE2
            IF(RE1.LT.0.)RE1=32768.+RE1
            IF(RE1.GE.16384.)RE1=RE1-16384.
            ARRAY(K)=RE1*65536.+RE2
      100   CONTINUE
      200   M=K-1
            END FILE LUF
            RETURN
            END
```

MIDAS FORTRAN IV   STORAGE MAP

NAME	OFFSET	ATTRIBUTES
LUF	000014	INTEGER*2 PARAMETER VARIABLE
M	000016	INTEGER*2 PARAMETER VARIABLE
IVAR	000024	INTEGER*2 VARIABLE
K	000026	INTEGER*2 VARIABLE
MSB	000030	INTEGER*2 VARIABLE
LSB	000032	INTEGER*2 VARIABLE
RE1	000034	REAL*4 VARIABLE
RE2	000040	REAL*4 VARIABLE

COMMON BLOCK /ARRAY/   LENGTH 004000

ARRAY	000000	REAL*4	ARRAY (512)

```
N         001406  INTEGER*2 VARIABLE
MAX0      000000  INTEGER*2 PROCEDURE

COMMON BLOCK /ARRAY/     LENGTH 004000

ARRAY     000000  REAL*4    ARRAY (512)


COMMON BLOCK /HEAD/      LENGTH 000200

HDR1      000000  REAL*8    ARRAY (8)
HDR2      000100  REAL*8    ARRAY (8)

COMMON BLOCK /DATA/      LENGTH 000240

DATA      000000  INTEGER*2 ARRAY (80)

COMMON BLOCK /FREE/      LENGTH 000340

INTEG     000000  INTEGER*2 ARRAY (16)
REALX     000040  REAL*4    ARRAY (16)
ALPHA     000140  REAL*8    ARRAY (16)
```

```
MIDAS FORTRAN IV   STORAGE MAP

NAME     OFFSET  ATTRIBUTES

X1       000014  REAL*4     PARAMETER ARRAY (8)
X2       000016  REAL*4     PARAMETER ARRAY (8)
Y1       000020  REAL*4     PARAMETER ARRAY (16)
Y2       000022  REAL*4     PARAMETER ARRAY (16)
S1       000042  REAL*4     PARAMETER ARRAY (16,8) VECTORED
S2       000044  REAL*4     PARAMETER ARRAY (16,8) VECTORED
P1       000032  REAL*4     PARAMETER ARRAY (8)
P2       000034  REAL*4     PARAMETER ARRAY (8)
Q1       000036  REAL*4     PARAMETER ARRAY (8)
Q2       000040  REAL*4     PARAMETER ARRAY (8)
H        000024  REAL*4     PARAMETER ARRAY (8)
V1       000026  REAL*4     PARAMETER ARRAY (8,8) VECTORED
V2       000030  REAL*4     PARAMETER ARRAY (8,8) VECTORED
FILDEF   000060  REAL*8     ARRAY (5)
N1       000046  INTEGER*2 PARAMETER VARIABLE
N2       000050  INTEGER*2 PARAMETER VARIABLE
M        000052  INTEGER*2 PARAMETER VARIABLE
MS       000054  INTEGER*2 PARAMETER VARIABLE
MF       000056  INTEGER*2 PARAMETER VARIABLE
CRT      000140  INTEGER*2 VARIABLE
PERIOD   000150  INTEGER*2 VARIABLE
BLANK    000152  INTEGER*2 VARIABLE
COMMA    000154  INTEGER*2 VARIABLE
ABLANK   000130  REAL*8     VARIABLE
LP       000142  INTEGER*2 VARIABLE
IN       000144  INTEGER*2 VARIABLE
IOUT     000146  INTEGER*2 VARIABLE
LUF      000156  INTEGER*2 VARIABLE
LEN      001322  INTEGER*2 VARIABLE
I        001324  INTEGER*2 VARIABLE
NX       001326  INTEGER*2 VARIABLE
MX       001330  INTEGER*2 VARIABLE
NA       001332  INTEGER*2 VARIABLE
FREEFM   000000  REAL*4     PROCEDURE
MCLI     000000  INTEGER*2 PROCEDURE
FX       001334  REAL*4     VARIABLE
MI       001340  INTEGER*2 VARIABLE
LIBIN    000000  INTEGER*2 PROCEDURE
ML       001342  INTEGER*2 VARIABLE
IJ       001344  INTEGER*2 VARIABLE
J        001346  INTEGER*2 VARIABLE
MJ       001350  INTEGER*2 VARIABLE
SUM      001352  REAL*4     VARIABLE
SUMY1    001356  REAL*4     VARIABLE
SUMY2    001362  REAL*4     VARIABLE
SUMX1    001366  REAL*4     VARIABLE
XNORM1   001372  REAL*4     VARIABLE
SUMX2    001376  REAL*4     VARIABLE
XNORM2   001402  REAL*4     VARIABLE
```

MCLI (MIDAS Command Line Interpreter) Subroutine

The MCLI subroutine linked to FORTRAN allows the user to perform MIDAS control console statements from a FORTRAN program. This routine is written in assembler.

Form

CALL MCLI (<string>[<var>])

where:

<string>	ASCII string to be executed; the string must have the same leading and terminating character; e.g., CALL MCLI ('@LUP@').
<var>	Optional integer variable to receive the error code. If no <var> is specified and an error occurs, then a direct return to MIDAS is taken.

Codes returned in <var> are as follows:

1 if no errors normal condition.

2 if CLI$ has returned an error.

3 if MIDAS command name is invalid.

Notes

The user should note that if MCLI is called with <1 or >2 arguments, then an immediate return is made to MIDAS.

The following MIDAS commands are forbidden in the MCLI subroutine: ABORT, BYE, CHAIN, DUPLICATE, ENDJOB, GOTO, HELLO, INIT, MESSAGE, PATCH, PAUSE, PROMPT, and REORDER.

The RUN command will cause the terminal to cease operating if either the calling program or the invoking program does an input from the terminal. The terminal will cease operating after both programs exit. This may require using CONTROL P to restore the terminal.

MTAPEF (FORMATTED MAGNETIC TAPE) SUBROUTINE

The MTAPEF subroutine controls the magnetic tape and its related functions. The subroutine is compatible with either 7 or 9 track magnetic tape. This subroutine is written in Assembler.

Form

CALL MTAPEF (a,b,c,d,e)

where:

a = Command: INTEGER*2 variable (required argument).
- = 1 - Initialize control formatter (a,b).
- = 2 - Transport off-line (a,b).
- = 3 - Rewind (a,b).
- = 4 - Search for logical EOT (a,b).
- = 5 - Search for file (a,b,c).
- = 6 - Search for record (a,b,c).
- = 7 - Read one record (a,b,c,d,e).
- = 8 - Verify one record (a,b,c,d,e).
- = 9 - Write one record (a,b,c,d).
- = 1Ø - Not used.
- = 11 - Over write one record (a,b,c,d).
- = 12 - Dump one record (a,b,c,d).
- = 13 - Write one filemark (a,b).
- = 14 - Write a logical EOT (a,b).
- = 15 - Open transport (a,b,c).
- = 16 - Close transport (a,b).
- = 17 - Tagword (a,b,c,d)

b = Error Number: INTEGER*2 variable (required).
- = 1 - No error.
- = 2 - Transport assigned to other/or no user.
- = 3 - Magnetic tape transport number error.
- = 4 - Segment is read only.
- = 5 - Segment is not accessible for I/O.
- = 6 - Memory is not contiguous.
- = 7 - Cross segments have different status.
- = 8 - No filemark detected for last operation.
- = 9 - Filemark detected during last operation.
- = 1Ø - Located on or past physical EOT.
- = 11 - Record read less than list word #14.
- = 12 - Record read greater than list word #14.
- = 13 - Invalid or undefined OP code.
- = 14 - Data late.
- = 15 - Invalid password.
- = 16 - Motion error.
- = 17 - Verification error.
- = 18 - Write protect error.
- = 19 - Parity CRC or LRC error during read.
- = 2Ø - Operation attempt on off-line transport.
- = 21 - No logical EOT detected during operation.

= 22 - Logical EOT detected during operation.
= 23 - Magnetic tape not off-line.
= 24 - Undefined error bit in status.
= 25 - Executive error during operation.
= 26 - Illegal number of arguments.
= 27 - Illegal command number.
= 28 - Record length greater than 513 bytes for 7 track transport.

c = Command Parameter 1: INTEGER*2 variable.

Command Number	Parameter
5	# files to skip
6	# records to skip
7	# bytes to skip
8	# bytes to skip
9	# bytes to write
11	# bytes to write
12	# bytes to write
15	# transport to open
17	Subcommand code (c) c = 1 - Get tagword c = 2 - Increment tagword c = 3 - Put tagword

d = Command Parameter 2: INTEGER*2 variable or array name.

Command Number	Parameter
7	# bytes to read
8	# bytes to verify
9	Array name to write
11	Array name to write
12	Array name to write
17	Get, Increment, or Put tagword

e = Command parameter 3: Integer variable.

Command Number	Parameter
7	Array name to read
8	Array name to verify

OANDC (Open and Close) Subroutine

The OANDC subroutine allows the user to open a file and get the parameters in the device control block (DCB) table. If the input parameter EMFLAG is set to zero, the file is opened. The end sector is moved to its maximum extent. If the file is empty, a flag is returned to the user as EMFLAG=1 to indicate file was empty. OANDC then closes the file so that the FORTRAN program can open it. If a FORTRAN program uses OANDC, the program must call OANDC before the first read/write to the logical unit in the FORTRAN program. This subroutine is written in assembler.

Form

```
CALL OANDC (lunit,error,dvcode,absect,vlsect,dataty,rcsize,bylast,emflag)
```

where:

All the parameters are integers and have the following values:

lunit — Logical unit number (1-12) of the file (input parameter).

error — Error flag. Contains system error number if error occurred; otherwise set to zero. A negative error number means open error; a positive error number means close error.

dvcode — Device code (output parameter).
= Ø - Teletype.
= 2 - Dummy device.
= 3 - Line printer.
= 4 - High speed paper tape punch.
= 5 - High speed paper tape reader.
= 6 - Disk file.

absect — Absolute number of sectors in the file (output parameter).

vlsect — Valid number of sectors in the file (output parameter).

dataty — Data type (Ø-255) (output parameter).

rcsize — Record size (Ø-255) (output parameter).

bylast — Number of bytes in the last sector (1-256) (output parameter).

emflag — Empty flag (input and output parameter).
Input - If zero, a file will have its end sector moved out to the absolute end sector minus one and bytes in the last sector set to 256.
Output - Set to one if file was empty.

Appendix D: IMSL* Subroutines

1. DDKALM (FTKALM)
2. LEQT1F
3. LUDATF
4. LUELMF
5. UERTST
6. VMULFF
7. VMULFP

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```
C      SUBROUTINE DDKALM
C    BASED ON IMSL ROUTINE NAME    - FTKALM
C
C-----------------------------------------------------------------------
C
C    COMPUTER              - ND 6620
C
C    LATEST REVISION       - JULY 1981 BY G.W.P.
C
C    PURPOSE               - KALMAN FILTERING
C
C    USAGE                 - CALL DDKALM(K,X,H,Y,S,Q,R,P,IN,IS,IL,N,M1,L,
C                              T1,T2,IT,T3,IER)
C
C    ARGUMENTS     K       - INPUT STEP COUNTER. K=0,1,2,...
C                              WHEN K IS EQUAL TO ZERO, VECTOR X SHOULD
C                              CONTAIN THE PRIOR ESTIMATE OF THE MEAN OF X,
C                              AND THE PROGRAM CALCULATES THE ESTIMATED
C                              VARIANCE OF X AS P=GQG-TRANSPOSE AT STEP 0.
C                  X       - INPUT/OUTPUT VECTOR OF LENGTH N. ON INPUT,
C                              X IS THE STATE VECTOR AT STEP K, AND ON
C                              OUTPUT, X CONTAINS THE ESTIMATED STATE
C                              VECTOR AT STEP K+1.
C                  H       - INPUT VECTOR OF DIMENSION N. H IS THE
C                              TRANSITION VECTOR AT STEP K.
C                  Y       - INPUT OBSERVATION VECTOR OF LENGTH M1 AT
C                              STEP K+1.
C                  S       - INPUT MATRIX OF DIMENSION M1 BY N AT STEP K+1.
C                  Q       - INPUT VARIANCE VECTOR OF DIMENSION L
C                              AT STEP K.
C                  R       - INPUT VARIANCE VECTOR OF DIMENSION
C                              M1 AT STEP K+1.
C                  P       - INPUT/OUTPUT MATRIX OF DIMENSION N BY N.
C                              ON INPUT, P IS THE VARIANCE MATRIX OF X
C                              AT STEP K.  ON OUTPUT, P IS THE ESTIMATED
C                              VARIANCE MATRIX OF X AT STEP K+1.
C                  IN      - INPUT ROW DIMENSION OF THE MATRICES H,G, AND P
C                              EXACTLY AS SPECIFIED IN THE DIMENSION STATE-
C                              MENT IN THE CALLING PROGRAM.
C                  IS      - INPUT ROW DIMENSION OF THE MATRICES S AND R
C                              EXACTLY AS SPECIFIED IN THE DIMENSION STATE-
C                              MENT IN THE CALLING PROGRAM.
C                  IL      - INPUT ROW DIMENSION OF THE MATRIX Q EXACTLY
C                              AS SPECIFIED IN THE DIMENSION STATEMENT IN
C                              THE CALLING PROGRAM.
```

```
      C                    N       - INPUT SCALAR. SEE DESCRIPTIONS OF X,H,G,M,P.
      C                                N MUST BE GREATER THAN 0.
      C                    M1      - INPUT SCALAR. SEE DESCRIPTIONS OF Y,S,R,T3.
      C                                M1 MUST BE GREATER THAN 0.
      C                    L       - INPUT SCALAR. SEE DESCRIPTIONS OF G,Q.
      C                                L MUST BE GREATER THAN 0.
      C     L MUST EQUAL N
      C                    T1      - WORK MATRIX OF DIMENSION NM BY NM1, WHERE
      C                                NM IS THE MAXIMUM OF N AND M1.
      C                    T2      - WORK MATRIX OF DIMENSION NM BY NML, WHERE
      C                                NML IS THE MAXIMUM OF NM AND L.
      C                    IT      - ROW DIMENSION OF THE MATRICES T1 AND T2
      C                                EXACTLY AS SPECIFIED IN THE DIMENSION
      C                                STATEMENT IN THE CALLING PROGRAM.
      C                    T3      - WORK VECTOR OF LENGTH M1.
      C                    IER     - ERROR PARAMETER. (OUTPUT)
      C                              TERMINAL ERROR
      C                                IER=129 INDICATES ONE OF IN, IS, IL, OR IT
      C                                  IS TOO SMALL, OR THAT ONE OF N, M1,
      C                                  OR L IS NOT A POSITIVE INTEGER.
      C                                IER=130 INDICATES AN ERROR OCCURRED IN
      C                                  IMSL ROUTINE LEQT1F.
      C
      C   REQD. IMSL ROUTINES - LEQT1F,LUDATF,LUELMF,UERTST,
      C     VMULFF,VMULFP,VXADD,VXMUL,VXSTO
      C-----------------------------------------------------------------------
```

```
      C
0001        SUBROUTINE DDKALM (K,X,H,Y,S,Q,R,P,IN,IS,IL,N,M1,L,T1,T2,IT,
           1                    T3,IER)
      C                                   SPECIFICATIONS FOR ARGUMENTS
0002        INTEGER             K,IN,IS,IL,N,M1,L,IT,IER
0003        REAL*4   X(1),H(IN),Y(1),S(IS,1),Q(IL),
           1                    R(IS),P(IN,1),T1(IT,1),T2(IT,1),T3(1)
      C                                   SPECIFICATIONS FOR LOCAL VARIABLES
0004        INTEGER             I,I0,I1,J
0005        DATA                I0/0/,I1/1/
      C                                   FIRST EXECUTABLE STATEMENT
0006        IF (IN.GE.N .AND. IS.GE.M1 .AND. IL.GE.L
           *   .AND. (IT.GE.N .OR. IT.GE.M1) .AND. N.GT.0
           *   .AND. M1.GT.0 .AND. L.GT.0) GO TO 5
0008        IER = 129
0009        GO TO 9000
0010      5 IER = 0
      D     CALL KPRINT(K,X,H,G,Y,S,Q,R,P,IN,IS,IL,N,M1,L)
      C                                   CALCULATE P IF K = ZERO
0011        IF (K .NE. 0) GO TO 10
0013        DO 6 I=1,N
0014        DO 6 J=1,N
0015  6     P(I,J)=0.
0016        DO 8 I=1,N
0017  8     P(I,I)=Q(I)
      C                                   CALCULATE X-PRIME AT STEP K+1
0018  10    DO 15 I=1,N
0019  15    X(I)=X(I)*H(I)
      C                                   CALCULATE P-PRIME AT STEP K+1
0020        DO 20 I=1,N
0021        DO 20 J=1,N
0022  20    P(I,J)=P(I,J)*H(I)*H(J)
0023        DO 25 I=1,N
0024  25    P(I,I)=P(I,I)+Q(I)
```

```
C                                   CALCULATE MATRIX K AT STEP K+1
C
      CALL VMULFP ( S, P,M1, N, N,IS,IN,T2,IT,IER)
      CALL VMULFP (T2, S,M1, N,M1,IT,IS,T1,IT,IER)
      DO 35 I = 1,M1
      T1(I,I)=T1(I,I)+R(I)
   35 CONTINUE
      CALL LEQT1F(T1, N,M1,IT,T2,I0,T3,IER)
      IF (IER .EQ. 0) GO TO 40
      IER = 130
      GO TO 9000
   40 DO 50 I = 1,M1
         DO 45 J = 1,N
            T1(J,I) = T2(I,J)
   45    CONTINUE
   50 CONTINUE                         CALCULATE X-HAT AT STEP K+1
C
   55 CALL VMULFF ( S, X,M1, N,I1,IS,IN,T3,IS,IER)
      DO 60 I = 1,M1
         T3(I) = T3(I) - Y(I)
   60 CONTINUE
      CALL VMULFF (T1,T3, N,M1,I1,IT,IS,T2,IT,IER)
      DO 65 I = 1,N
         X(I) = X(I) - T2(I,1)
   65 CONTINUE                         CALCULATE P AT STEP K+1
C
      CALL VMULFF (T1, S, N,M1, N,IT,IS,T2,IT,IER)
      CALL VMULFF (T2, P, N, N, N,IT,IN,T1,IT,IER)
      DO 75 I = 1,N
         DO 70 J = 1,N
            P(I,J) = P(I,J) - T1(I,J)
   70    CONTINUE
   75 CONTINUE
      GO TO 9005
 9000 CONTINUE
      CALL UERTST (IER,6HDDKALM)
 9005 RETURN
      END
```

MIDAS FORTRAN IV   STORAGE MAP

NAME	OFFSET	ATTRIBUTES		
X	000016	REAL*4	PARAMETER	ARRAY (1)
H	000020	REAL*4	PARAMETER	ARRAY (IN)
IN	000034	INTEGER*2	PARAMETER	VARIABLE
Y	000022	REAL*4	PARAMETER	ARRAY (1)
S	000024	REAL*4	PARAMETER	ARRAY (IS,1)
IS	000036	INTEGER*2	PARAMETER	VARIABLE
Q	000026	REAL*4	PARAMETER	ARRAY (IL)
IL	000040	INTEGER*2	PARAMETER	VARIABLE
R	000030	REAL*4	PARAMETER	ARRAY (IS)
P	000032	REAL*4	PARAMETER	ARRAY (IN,1)
T1	000050	REAL*4	PARAMETER	ARRAY (IT,1)
IT	000054	INTEGER*2	PARAMETER	VARIABLE
T2	000052	REAL*4	PARAMETER	ARRAY (IT,1)
T3	000056	REAL*4	PARAMETER	ARRAY (1)
K	000014	INTEGER*2	PARAMETER	VARIABLE
N	000042	INTEGER*2	PARAMETER	VARIABLE
M1	000044	INTEGER*2	PARAMETER	VARIABLE
L	000046	INTEGER*2	PARAMETER	VARIABLE
IER	000060	INTEGER*2	PARAMETER	VARIABLE
I	000076	INTEGER*2	VARIABLE	
I0	000062	INTEGER*2	VARIABLE	
I1	000064	INTEGER*2	VARIABLE	
J	000100	INTEGER*2	VARIABLE	
VMULFP	000000	REAL*4	PROCEDURE	
LEQT1F	000000	INTEGER*2	PROCEDURE	
VMULFF	000000	REAL*4	PROCEDURE	
UERTST	000000	REAL*4	PROCEDURE	

```
C   IMSL ROUTINE NAME   - LEQT1F
C
C-----------------------------------------------------------------------
C
C   COMPUTER            - ND 6620
C
C   LATEST REVISION     - MAY 1981 BY G.W.P.
C
C   PURPOSE             - LINEAR EQUATION SOLUTION - FULL STORAGE
C                           MODE - SPACE ECONOMIZER SOLUTION.
C
C   USAGE               - CALL LEQT1F (A,M,N,IA,B,IDGT,WKAREA,IER)
C
C   ARGUMENTS    A      - INPUT MATRIX OF DIMENSION N BY N CONTAINING
C                           THE COEFFICIENT MATRIX OF THE EQUATION
C                           AX = B.
C                         ON OUTPUT, A IS REPLACED BY THE LU
C                           DECOMPOSITION OF A ROWWISE PERMUTATION OF
C                           A.
C                M      - NUMBER OF RIGHT-HAND SIDES. (INPUT)
C                N      - ORDER OF A AND NUMBER OF ROWS IN B. (INPUT)
C                IA     - ROW DIMENSION OF A AND B EXACTLY AS SPECIFIED
C                           IN THE DIMENSION STATEMENT OF THE CALLING
C                           PROGRAM. (INPUT)
C                B      - INPUT MATRIX OF DIMENSION N BY M CONTAINING
C                           RIGHT-HAND SIDES OF THE EQUATION AX = B.
C                         ON OUTPUT, THE N BY M SOLUTION X REPLACES B.
C                IDGT   - INPUT OPTION.
C                         IF IDGT IS GREATER THAN 0, THE ELEMENTS OF
C                           A AND B ARE ASSUMED TO BE CORRECT TO IDGT
C                           DECIMAL DIGITS AND THE ROUTINE PERFORMS
C                           AN ACCURACY TEST.
C                         IF IDGT EQUALS ZERO, THE ACCURACY TEST IS
C                           BYPASSED.
C                WKAREA - WORK AREA OF DIMENSION GREATER THAN OR EQUAL
C                           TO N.
C                IER    - ERROR PARAMETER. (OUTPUT)
C                         TERMINAL ERROR
C                           IER = 129 INDICATES THAT MATRIX A IS
C                             ALGORITHMICALLY SINGULAR. (SEE THE
C                             CHAPTER L PRELUDE).
C                         WARNING ERROR
C                           IER = 34 INDICATES THAT THE ACCURACY TEST
C                             FAILED.  THE COMPUTED SOLUTION MAY BE IN
C                             ERROR BY MORE THAN CAN BE ACCOUNTED FOR
C                             BY THE UNCERTAINTY OF THE DATA.  THIS
C                             WARNING CAN BE PRODUCED ONLY IF IDGT IS
C                             GREATER THAN 0 ON INPUT.  (SEE CHAPTER L
C                             PRELUDE FOR FURTHER DISCUSSION).
C
C-----------------------------------------------------------------------
```

```
DAS FORTRAN IV            7 JUL 1981  3:01:00 PM      PAGE 002

     C
001        SUBROUTINE LEQT1F (A,M,N,IA,B,IDGT,WKAREA,IER)
     C
002        DIMENSION            A(IA,1),B(IA,1),WKAREA(1)
     C                                    INITIALIZE IER
     C                                    FIRST EXECUTABLE STATEMENT
003        IER=0
     C                                    DECOMPOSE A
004        CALL LUDATF (A,A,N,IA,IDGT,D1,D2,WKAREA,WKAREA,WA,IER)
005        IF (IER .GT. 128) GO TO 9000
     C                                    CALL ROUTINE LUELMF (FORWARD AND
     C                                    BACKWARD SUBSTITUTIONS)
007        DO 10 J=1,M
008           CALL LUELMF (A,B(1,J),WKAREA,N,IA,B(1,J))
009     10 CONTINUE
010        IF (IER .EQ. 0) GO TO 9005
012   9000 CONTINUE
013        CALL UERTST (IER,6HLEQT1F)
014   9005 RETURN
015        END
```

```
IIDAS FORTRAN IV   STORAGE MAP


IAME     OFFSET  ATTRIBUTES

I        000014  REAL*4     PARAMETER ARRAY (IA,1)
IA       000022  INTEGER*2  PARAMETER VARIABLE
B        000024  REAL*4     PARAMETER ARRAY (IA,1)
JKAREA   000030  REAL*4     PARAMETER ARRAY (1)
1        000016  INTEGER*2  PARAMETER VARIABLE
I        000020  INTEGER*2  PARAMETER VARIABLE
IDGT     000026  INTEGER*2  PARAMETER VARIABLE
IER      000032  INTEGER*2  PARAMETER VARIABLE
.UDATF   000000  INTEGER*2  PROCEDURE
)1       000044  REAL*4     VARIABLE
)2       000050  REAL*4     VARIABLE
JA       000054  REAL*4     VARIABLE
I        000060  INTEGER*2  VARIABLE
.UELMF   000000  INTEGER*2  PROCEDURE
JERTST   000000  REAL*4     PROCEDURE
```

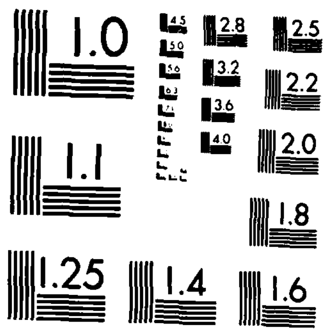
```
C   IMSL ROUTINE NAME   - LUDATF
C
C-----------------------------------------------------------------------
C
C   COMPUTER            - ND6620
C
C   LATEST REVISION     - MAY 1981 BY G.W.P
C
C   PURPOSE             - L-U DECOMPOSITION BY THE CROUT ALGORITHM
C                           WITH OPTIONAL ACCURACY TEST.
C
C   USAGE               - CALL LUDATF (A,LU,N,IA,IDGT,D1,D2,IPVT,
C                           EQUIL,WA,IER)
C
C   ARGUMENTS    A      - INPUT MATRIX OF DIMENSION N BY N CONTAINING
C                           THE MATRIX TO BE DECOMPOSED.
C                LU     - REAL OUTPUT MATRIX OF DIMENSION N BY N
C                           CONTAINING THE L-U DECOMPOSITION OF A
C                           ROWWISE PERMUTATION OF THE INPUT MATRIX.
C                           FOR A DESCRIPTION OF THE FORMAT OF LU, SEE
C                           EXAMPLE.
C                N      - INPUT SCALAR CONTAINING THE ORDER OF THE
C                           MATRIX A.
C                IA     - INPUT SCALAR CONTAINING THE ROW DIMENSION OF
C                           MATRICES A AND LU EXACTLY AS SPECIFIED IN
C                           THE CALLING PROGRAM.
C                IDGT   - INPUT OPTION.
C                           IF IDGT IS GREATER THAN ZERO, THE NON-ZERO
C                           ELEMENTS OF A ARE ASSUMED TO BE CORRECT TO
C                           IDGT DECIMAL PLACES.  LUDATF PERFORMS AN
C                           ACCURACY TEST TO DETERMINE IF THE COMPUTED
C                           DECOMPOSITION IS THE EXACT DECOMPOSITION
C                           OF A MATRIX WHICH DIFFERS FROM THE GIVEN
C                           ONE BY LESS THAN ITS UNCERTAINTY.
C                         IF IDGT IS EQUAL TO ZERO, THE ACCURACY TEST
C                           IS BYPASSED.
```

```
C                 D1      - OUTPUT SCALAR CONTAINING ONE OF THE TWO
C                             COMPONENTS OF THE DETERMINANT. SEE
C                             DESCRIPTION OF PARAMETER D2, BELOW.
C                 D2      - OUTPUT SCALAR CONTAINING ONE OF THE
C                             TWO COMPONENTS OF THE DETERMINANT. THE
C                             DETERMINANT MAY BE EVALUATED AS (D1)(2**D2).
C                 IPVT    - OUTPUT VECTOR OF LENGTH N CONTAINING THE
C                             PERMUTATION INDICES. SEE DOCUMENT
C                             (ALGORITHM).
C                 EQUIL   - OUTPUT VECTOR OF LENGTH N CONTAINING
C                             RECIPROCALS OF THE ABSOLUTE VALUES OF
C                             THE LARGEST (IN ABSOLUTE VALUE) ELEMENT
C                             IN EACH ROW.
C                 WA      - ACCURACY TEST PARAMETER, OUTPUT ONLY IF
C                             IDGT IS GREATER THAN ZERO.
C                             SEE ELEMENT DOCUMENTATION FOR DETAILS.
C                 IER     - ERROR PARAMETER. (OUTPUT)
C                           TERMINAL ERROR
C                             IER = 129 INDICATES THAT MATRIX A IS
C                               ALGORITHMICALLY SINGULAR. (SEE THE
C                               CHAPTER L PRELUDE).
C                           WARNING ERROR
C                             IER = 34 INDICATES THAT THE ACCURACY TEST
C                               FAILED.  THE COMPUTED SOLUTION MAY BE IN
C                               ERROR BY MORE THAN CAN BE ACCOUNTED FOR
C                               BY THE UNCERTAINTY OF THE DATA.  THIS
C                               WARNING CAN BE PRODUCED ONLY IF IDGT IS
C                               GREATER THAN 0 ON INPUT.  SEE CHAPTER L
C                               PRELUDE FOR FURTHER DISCUSSION.
C
C   REQD. IMSL ROUTINES - UERTST,UGETIO
C
C   REMARKS       A TEST FOR SINGULARITY IS MADE AT TWO LEVELS:
C                 1.  A ROW OF THE ORIGINAL MATRIX A IS NULL.
C                 2.  A COLUMN BECOMES NULL IN THE FACTORIZATION PROCESS.
C
C
C-----------------------------------------------------------------------
```

AD-A154 995 KALMAN FILTER TIME SERIES ANALYSIS OF GAMMA-RAY DATA FROM NAI(T1) DETECTORS FOR THE ND6620 COMPUTER(U) NAVAL RESEARCH LAB WASHINGTON DC G W PHILLIPS 08 MAY 85 2/2

UNCLASSIFIED NRL-MR-5541 F/G 20/6 NL

END
FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
      C
            SUBROUTINE LUDATF (A,ALU,N,IA,IDGT,D1,D2,IPVT,EQUIL,WA,IER)
      C
            DIMENSION          A(IA,1),ALU(IA,1),IPVT(1),EQUIL(1)
            DATA               ZERO,ONE,FOUR,SIXTN,SIXTH/0.,1.,4.,
           *                   16.,.0625/
      C                                   FIRST EXECUTABLE STATEMENT
      C                                   INITIALIZATION
      D     WRITE(6,1000)
      D1000 FORMAT(1H0,'ENTERING LUDATF. INPUT MATRIX')
      D     DO 1020 I=1,N
      D     WRITE(6,1010)(A(I,J),J=1,N)
      D1010 FORMAT(1X,8G13.3/(5X,8G13.3))
      D1020 CONTINUE
            IER = 0
            RN = N
            WREL = ZERO
            D1 = ONE
            D2 = ZERO
            BIGA = ZERO
            DO 10 I=1,N
               BIG = ZERO
               DO 5 J=1,N
                  P = A(I,J)
                  ALU(I,J) = P
                  P = ABS(P)
                  IF (P .GT. BIG) BIG = P
          5    CONTINUE
               IF (BIG .GT. BIGA) BIGA = BIG
               IF (BIG .EQ. ZERO) GO TO 110
               EQUIL(I) = ONE/BIG
         10 CONTINUE
            DO 105 J=1,N
               JM1 = J-1
               IF (JM1 .LT. 1) GO TO 40
```

```
      C                                    COMPUTE U(I,J), I=1,....,J-1
                DO 35 I=1,JM1
                   SUM = ALU(I,J)
                   IM1 = I-1
                   IF (IDGT .EQ. 0) GO TO 25
      C                                    WITH ACCURACY TEST
                   AI = ABS(SUM)
                   WI = ZERO
                   IF (IM1 .LT. 1) GO TO 20
                   DO 15 K=1,IM1
                      T = ALU(I,K)*ALU(K,J)
                      SUM = SUM-T
                      WI = WI+ABS(T)
         15        CONTINUE
                   ALU(I,J) = SUM
         20        WI = WI+ABS(SUM)
                   IF (AI .EQ. ZERO) AI = BIGA
                   TEST = WI/AI
                   IF (TEST .GT. WREL) WREL = TEST
                   GO TO 35
      C                                    WITHOUT ACCURACY
         25        IF (IM1 .LT. 1) GO TO 35
                   DO 30 K=1,IM1
                      SUM = SUM-ALU(I,K)*ALU(K,J)
         30        CONTINUE
                   ALU(I,J) = SUM
         35     CONTINUE
         40     P = ZERO
```

```
C                                  COMPUTE U(J,J) AND L(I,J), I=J+1,....,
            DO 70 I=J,N
               SUM = ALU(I,J)
               IF (IDGT .EQ. 0) GO TO 55
C                                  WITH ACCURACY TEST
               AI = ABS(SUM)
               WI = ZERO
               IF (JM1 .LT. 1) GO TO 50
               DO 45 K=1,JM1
                  T = ALU(I,K)*ALU(K,J)
                  SUM = SUM-T
                  WI = WI+ABS(T)
   45          CONTINUE
               ALU(I,J) = SUM
   50          WI = WI+ABS(SUM)
               IF (AI .EQ. ZERO) AI = BIGA
               TEST = WI/AI
               IF (TEST .GT. WREL) WREL = TEST
               GO TO 65
C                                  WITHOUT ACCURACY TEST
   55          IF (JM1 .LT. 1) GO TO 65
               DO 60 K=1,JM1
                  SUM = SUM-ALU(I,K)*ALU(K,J)
   60          CONTINUE
               ALU(I,J) = SUM
   65          Q = EQUIL(I)*ABS(SUM)
               IF (P .GE. Q) GO TO 70
               P = Q
               IMAX = I
   70       CONTINUE
```

```
C                                     TEST FOR ALGORITHMIC SINGULARITY
            IF (RN+P .EQ. RN) GO TO 110
            IF (J .EQ. IMAX) GO TO 80
C                                     INTERCHANGE ROWS J AND IMAX
            D1 = -D1
            DO 75 K=1,N
               P = ALU(IMAX,K)
               ALU(IMAX,K) = ALU(J,K)
               ALU(J,K) = P
   75       CONTINUE
            EQUIL(IMAX) = EQUIL(J)
   80       IPVT(J) = IMAX
            D1 = D1*ALU(J,J)
   85       IF (ABS(D1) .LE. ONE) GO TO 90
            D1 = D1*SIXTH
            D2 = D2+FOUR
            GO TO 85
   90       IF (ABS(D1) .GE. SIXTH) GO TO 95
            D1 = D1*SIXTN
            D2 = D2-FOUR
            GO TO 90
   95       CONTINUE
            JP1 = J+1
            IF (JP1 .GT. N) GO TO 105
C                                     DIVIDE BY PIVOT ELEMENT U(J,J)
            P = ALU(J,J)
            DO 100 I=JP1,N
               ALU(I,J) = ALU(I,J)/P
  100       CONTINUE
  105 CONTINUE
```

```
      C                                 PERFORM ACCURACY TEST
0124        IF (IDGT .EQ. 0) GO TO 9005
0126        P = 3*N+3
0127        WA = P*WREL
0128        IF (WA+10.**(-IDGT) .NE. WA) GO TO 9005
0130        IER = 34
0131        GO TO 9000
      C                                 ALGORITHMIC SINGULARITY
0132     110 IER = 129
0133        D1 = ZERO
0134        D2 = ZERO
0135    9000 CONTINUE
      C                                 PRINT ERROR
0136        CALL UERTST(IER,6HLUDATF)
      D     STOP
      C
0137    9005 RETURN
0138        END
```

MIDAS FORTRAN IV   STORAGE MAP

NAME	OFFSET	ATTRIBUTES		
A	000014	REAL*4	PARAMETER	ARRAY (IA,1)
IA	000022	INTEGER*2	PARAMETER	VARIABLE
ALU	000016	REAL*4	PARAMETER	ARRAY (IA,1)
IPVT	000032	INTEGER*2	PARAMETER	ARRAY (1)
EQUIL	000034	REAL*4	PARAMETER	ARRAY (1)
N	000020	INTEGER*2	PARAMETER	VARIABLE
IDGT	000024	INTEGER*2	PARAMETER	VARIABLE
D1	000026	REAL*4	PARAMETER	VARIABLE
D2	000030	REAL*4	PARAMETER	VARIABLE
WA	000036	REAL*4	PARAMETER	VARIABLE
IER	000040	INTEGER*2	PARAMETER	VARIABLE
ZERO	000042	REAL*4	VARIABLE	
ONE	000046	REAL*4	VARIABLE	
FOUR	000052	REAL*4	VARIABLE	
SIXTN	000056	REAL*4	VARIABLE	
SIXTH	000062	REAL*4	VARIABLE	
RN	000076	REAL*4	VARIABLE	
WREL	000102	REAL*4	VARIABLE	
BIGA	000106	REAL*4	VARIABLE	
I	000112	INTEGER*2	VARIABLE	
BIG	000114	REAL*4	VARIABLE	
J	000120	INTEGER*2	VARIABLE	
P	000122	REAL*4	VARIABLE	
ABS	000000	REAL*4	PROCEDURE	
JM1	000126	INTEGER*2	VARIABLE	
SUM	000130	REAL*4	VARIABLE	
IM1	000134	INTEGER*2	VARIABLE	
AI	000136	REAL*4	VARIABLE	
WI	000142	REAL*4	VARIABLE	
K	000146	INTEGER*2	VARIABLE	
T	000150	REAL*4	VARIABLE	
TEST	000154	REAL*4	VARIABLE	
Q	000160	REAL*4	VARIABLE	
IMAX	000164	INTEGER*2	VARIABLE	
JP1	000166	INTEGER*2	VARIABLE	
UERTST	000000	REAL*4	PROCEDURE	

```
C   IMSL ROUTINE NAME   - LUELMF
C
C-----------------------------------------------------------------------
C
C   COMPUTER            - ND 6620
C
C   LATEST REVISION     - MAY 1981 BY G.W.P.
C
C   PURPOSE             - ELIMINATION PART OF SOLUTION OF AX=B
C                           (FULL STORAGE MODE)
C
C   USAGE               - CALL LUELMF (A,B,IPVT,N,IA,X)
C
C   ARGUMENTS    A      - A = LU (THE RESULT COMPUTED IN THE IMSL
C                           ROUTINE LUDATF) WHERE L IS A LOWER
C                           TRIANGULAR MATRIX WITH ONES ON THE MAIN
C                           DIAGONAL. U IS UPPER TRIANGULAR. L AND U
C                           ARE STORED AS A SINGLE MATRIX A AND THE
C                           UNIT DIAGONAL OF L IS NOT STORED. (INPUT)
C                B      - B IS A VECTOR OF LENGTH N ON THE RIGHT HAND
C                           SIDE OF THE EQUATION AX=B. (INPUT)
C                IPVT   - THE PERMUTATION MATRIX RETURNED FROM THE
C                           IMSL ROUTINE LUDATF, STORED AS AN N LENGTH
C                           VECTOR. (INPUT)
C                N      - ORDER OF A AND NUMBER OF ROWS IN B. (INPUT)
C                IA     - ROW DIMENSION OF A EXACTLY AS SPECIFIED IN
C                           THE DIMENSION STATEMENT IN THE CALLING
C                           PROGRAM. (INPUT)
C                X      - THE RESULT X. (OUTPUT)
C
C-----------------------------------------------------------------------
```

```
      C
0001        SUBROUTINE LUELMF (A,B,IPVT,N,IA,X)
      C
0002        DIMENSION          A(IA,1),B(1),IPVT(1),X(1)
      C                                 FIRST EXECUTABLE STATEMENT
      C                                 SOLVE LY = B FOR Y
0003        DO 5 I=1,N
0004      5 X(I) = B(I)
0005        IW = 0
0006        DO 20 I=1,N
0007           IP = IPVT(I)
0008           SUM = X(IP)
0009           X(IP) = X(I)
0010           IF (IW .EQ. 0) GO TO 15
0012           IM1 = I-1
0013           DO 10 J=IW,IM1
0014              SUM = SUM-A(I,J)*X(J)
0015     10    CONTINUE
0016           GO TO 20
0017     15    IF (SUM .NE. 0.) IW = I
0019     20 X(I) = SUM
      C                                 SOLVE UX = Y FOR X
0020        DO 30 IB=1,N
0021           I = N+1-IB
0022           IP1 = I+1
0023           SUM = X(I)
0024           IF (IP1 .GT. N) GO TO 30
0026           DO 25 J=IP1,N
0027              SUM = SUM-A(I,J)*X(J)
0028     25    CONTINUE
0029     30 X(I) = SUM/A(I,I)
0030        RETURN
0031        END
```

MIDAS FORTRAN IV   STORAGE MAP

```
NAME     OFFSET  ATTRIBUTES

A        000014  REAL*4     PARAMETER ARRAY (IA,1)
IA       000024  INTEGER*2  PARAMETER VARIABLE
B        000016  REAL*4     PARAMETER ARRAY (1)
IPVT     000020  INTEGER*2  PARAMETER ARRAY (1)
X        000026  REAL*4     PARAMETER ARRAY (1)
N        000022  INTEGER*2  PARAMETER VARIABLE
I        000030  INTEGER*2  VARIABLE
IW       000032  INTEGER*2  VARIABLE
IP       000034  INTEGER*2  VARIABLE
SUM      000036  REAL*4     VARIABLE
IM1      000042  INTEGER*2  VARIABLE
J        000044  INTEGER*2  VARIABLE
IB       000046  INTEGER*2  VARIABLE
IP1      000050  INTEGER*2  VARIABLE
```

```
C   IMSL ROUTINE NAME   - UERTST
C
C-----------------------------------------------------------------------
C
C   COMPUTER            - ND 6620
C
C   LATEST REVISION     - MAY 1981 BY G.W.P.
C
C   PURPOSE             - PRINT A MESSAGE REFLECTING AN ERROR CONDITION
C
C   USAGE               - CALL UERTST (IER,NAME)
C
C   ARGUMENTS    IER    - ERROR PARAMETER. (INPUT)
C                           IER = I+J WHERE
C                             I = 128 IMPLIES TERMINAL ERROR.
C                             I =  64 IMPLIES WARNING WITH FIX, AND
C                             I =  32 IMPLIES WARNING.
C                             J = ERROR CODE RELEVANT TO CALLING
C                                 ROUTINE.
C                NAME   - A SIX CHARACTER LITERAL STRING GIVING THE
C                           NAME OF THE CALLING ROUTINE. (INPUT)
C
C-----------------------------------------------------------------------
```

```
C
      SUBROUTINE UERTST (IER,NAME)
C                                  SPECIFICATIONS FOR ARGUMENTS
      INTEGER            IER
      INTEGER*2          NAME(3)
C                                  SPECIFICATIONS FOR LOCAL VARIABLES
      INTEGER*2          NAMSET(3),NAMEQ(3)
      DATA                IOUNIT/7/
      DATA               NAMSET/2HUE,2HRS,2HET/
      DATA               NAMEQ/2H  ,2H  ,2H  /
C                                  FIRST EXECUTABLE STATEMENT
      DATA               LEVEL/4/,IEQDF/0/,IEQ/1H=/
      IF (IER.GT.999) GO TO 25
      IF (IER.LT.-32) GO TO 55
      IF (IER.LE.128) GO TO 5
      IF (LEVEL.LT.1) GO TO 30
C                                  PRINT TERMINAL MESSAGE
      IF (IEQDF.EQ.1) WRITE(IOUNIT,35) IER,NAMEQ,IEQ,NAME
      IF (IEQDF.EQ.0) WRITE(IOUNIT,35) IER,NAME
      GO TO 30
    5 IF (IER.LE.64) GO TO 10
      IF (LEVEL.LT.2) GO TO 30
C                                  PRINT WARNING WITH FIX MESSAGE
      IF (IEQDF.EQ.1) WRITE(IOUNIT,40) IER,NAMEQ,IEQ,NAME
      IF (IEQDF.EQ.0) WRITE(IOUNIT,40) IER,NAME
      GO TO 30
   10 IF (IER.LE.32) GO TO 15
C                                  PRINT WARNING MESSAGE
      IF (LEVEL.LT.3) GO TO 30
      IF (IEQDF.EQ.1) WRITE(IOUNIT,45) IER,NAMEQ,IEQ,NAME
      IF (IEQDF.EQ.0) WRITE(IOUNIT,45) IER,NAME
      GO TO 30
   15 CONTINUE
C                                  CHECK FOR UERSET CALL
      DO 20 I=1,3
         IF (NAME(I).NE.NAMSET(I)) GO TO 25
   20 CONTINUE
      LEVOLD = LEVEL
      LEVEL = IER
      IER = LEVOLD
      IF (LEVEL.LT.0) LEVEL = 4
      IF (LEVEL.GT.4) LEVEL = 4
      GO TO 30
   25 CONTINUE
      IF (LEVEL.LT.4) GO TO 30
```

```
C                                       PRINT NON-DEFINED MESSAGE
        IF (IEQDF.EQ.1) WRITE(IOUNIT,50) IER,NAMEQ,IEQ,NAME
        IF (IEQDF.EQ.0) WRITE(IOUNIT,50) IER,NAME
     30 IEQDF = 0
        RETURN
     35 FORMAT(19H *** TERMINAL ERROR,10X,7H(IER = ,I3,
       1       20H) FROM IMSL ROUTINE ,3A2,A1,3A2)
     40 FORMAT(36H *** WARNING WITH FIX ERROR  (IER = ,I3,
       1       20H) FROM IMSL ROUTINE ,3A2,A1,3A2)
     45 FORMAT(18H *** WARNING ERROR,11X,7H(IER = ,I3,
       1       20H) FROM IMSL ROUTINE ,3A2,A1,3A2)
     50 FORMAT(20H *** UNDEFINED ERROR,9X,7H(IER = ,I5,
       1       20H) FROM IMSL ROUTINE ,3A2,A1,3A2)
C                                       SAVE P FOR P = R CASE
C                                         P IS THE PAGE NAME
C                                         R IS THE ROUTINE NAME
     55 IEQDF = 1
        DO 60 I=1,3
     60 NAMEQ(I) = NAME(I)
     65 RETURN
        END
```

NAME	OFFSET	ATTRIBUTES
NAME	000016	INTEGER*2 PARAMETER ARRAY (3)
NAMSET	000020	INTEGER*2 ARRAY (3)
NAMEQ	000026	INTEGER*2 ARRAY (3)
IER	000014	INTEGER*2 PARAMETER VARIABLE
IOUNIT	000034	INTEGER*2 VARIABLE
LEVEL	000036	INTEGER*2 VARIABLE
IEQDF	000040	INTEGER*2 VARIABLE
IEQ	000042	INTEGER*2 VARIABLE
I	000460	INTEGER*2 VARIABLE
LEVOLD	000462	INTEGER*2 VARIABLE

```
C   IMSL ROUTINE NAME   - VMULFF
C
C-----------------------------------------------------------------------
C
C   COMPUTER            - ND 6620
C
C   LATEST REVISION     - MAY 1981 BY G.W.P.
C
C   PURPOSE             - MATRIX MULTIPLICATION (FULL STORAGE MODE)
C
C   USAGE               - CALL VMULFF (A,B,L,M,N,IA,IB,C,IC,IER)
C
C   ARGUMENTS    A      - L BY M MATRIX STORED IN FULL STORAGE MODE.
C                           (INPUT)
C                B      - M BY N MATRIX STORED IN FULL STORAGE MODE.
C                           (INPUT)
C                L      - NUMBER OF ROWS IN A. (INPUT)
C                M      - NUMBER OF COLUMNS IN A (SAME AS NUMBER OF
C                           ROWS IN B). (INPUT)
C                N      - NUMBER OF COLUMNS IN B. (INPUT)
C                IA     - ROW DIMENSION OF MATRIX A EXACTLY AS
C                           SPECIFIED IN THE DIMENSION STATEMENT IN THE
C                           CALLING PROGRAM. (INPUT)
C                IB     - ROW DIMENSION OF MATRIX B EXACTLY AS
C                           SPECIFIED IN THE DIMENSION STATEMENT IN THE
C                           CALLING PROGRAM. (INPUT)
C                C      - L BY N MATRIX CONTAINING THE PRODUCT
C                           C = A*B. (OUTPUT)
C                IC     - ROW DIMENSION OF MATRIX C EXACTLY AS
C                           SPECIFIED IN THE DIMENSION STATEMENT IN THE
C                           CALLING PROGRAM. (INPUT)
C                IER    - ERROR PARAMETER. (OUTPUT)
C                         TERMINAL ERROR
C                           IER=129 INDICATES A,B,OR C WAS DIMENSIONED
C                             INCORRECTLY.
C
C   REQD. IMSL ROUTINES - UERTST
C
C-----------------------------------------------------------------------
```

```
C
      SUBROUTINE VMULFF (A,B,L,M,N,IA,IB,C,IC,IER)
C
C                                            SPECIFICATIONS FOR ARGUMENTS
      INTEGER             L,M,N,IA,IB,IC,IER
      REAL*4    A(IA,M),B(IB,N),C(IC,N)
C                                            SPECIFICATIONS FOR LOCAL VARIABLES
      DOUBLE PRECISION    TEMP
C                                            FIRST EXECUTABLE STATEMENT
      IF (IA .GE. L .AND. IB .GE. M .AND. IC .GE. L) GO TO 5
C                                            TERMINAL ERROR
      IER=129
      GO TO 9000
C                                            ROW INDICATOR
    5 IER = 0
      DO 15 I=1,L
C                                            COLUMN INDICATOR
         DO 15 J=1,N
            TEMP=0.0
C                                            VECTOR DOT PRODUCT
            DO 10 K=1,M
               TEMP=A(I,K)*B(K,J)+TEMP
   10       CONTINUE
            C(I,J)=TEMP
   15 CONTINUE
      GO TO 9005
 9000 CONTINUE
      CALL UERTST (IER,6HVMULFF)
 9005 RETURN
      END
```

MIDAS FORTRAN IV   STORAGE MAP

NAME	OFFSET	ATTRIBUTES		
A	000314	REAL*4	PARAMETER	ARRAY (IA,M)
IA	000026	INTEGER*2	PARAMETER	VARIABLE
M	000022	INTEGER*2	PARAMETER	VARIABLE
B	000016	REAL*4	PARAMETER	ARRAY (IB,N)
IB	000030	INTEGER*2	PARAMETER	VARIABLE
N	000024	INTEGER*2	PARAMETER	VARIABLE
C	000032	REAL*4	PARAMETER	ARRAY (IC,N)
IC	000034	INTEGER*2	PARAMETER	VARIABLE
L	000020	INTEGER*2	PARAMETER	VARIABLE
IER	000036	INTEGER*2	PARAMETER	VARIABLE
TEMP	000050	REAL*8	VARIABLE	
I	000060	INTEGER*2	VARIABLE	
J	000062	INTEGER*2	VARIABLE	
K	000064	INTEGER*2	VARIABLE	
UERTST	000000	REAL*4	PROCEDURE	

```
C   IMSL ROUTINE NAME   - VMULFP
C
C-----------------------------------------------------------------------
C
C   COMPUTER            - ND6620
C
C   LATEST REVISION     - MAY 1981 BY G.W.P.
C
C   PURPOSE             - MATRIX MULTIPLICATION OF MATRIX A BY THE
C                           TRANSPOSE OF MATRIX B (FULL STORAGE MODE)
C
C   USAGE               - CALL VMULFP (A,B,L,M,N,IA,IB,C,IC,IER)
C
C   ARGUMENTS    A      - L BY M MATRIX STORED IN FULL STORAGE MODE.
C                           (INPUT)
C                B      - N BY M MATRIX STORED IN FULL STORAGE MODE.
C                           (INPUT)
C                L      - NUMBER OF ROWS IN A AND C. (INPUT)
C                M      - NUMBER OF COLUMNS IN A AND B. (INPUT)
C                N      - NUMBER OF ROWS IN MATRIX B AND NUMBER OF
C                           COLUMNS IN MATRIX C. (INPUT)
C                IA     - ROW DIMENSION OF MATRIX A EXACTLY AS
C                           SPECIFIED IN THE DIMENSION STATEMENT IN THE
C                           CALLING PROGRAM. (INPUT)
C                IB     - ROW DIMENSION OF MATRIX B EXACTLY AS
C                           SPECIFIED IN THE DIMENSION STATEMENT IN THE
C                           CALLING PROGRAM. (INPUT)
C                C      - L BY N MATRIX CONTAINING THE PRODUCT
C                           C = A*B-TRANSPOSE. (OUTPUT)
C                IC     - ROW DIMENSION OF MATRIX C EXACTLY AS
C                           SPECIFIED IN THE DIMENSION STATEMENT IN THE
C                           CALLING PROGRAM. (INPUT)
C                IER    - ERROR PARAMETER.
C                         TERMINAL ERROR
C                           IER=129 INDICATES A,B,OR C WAS DIMENSIONED
C                             INCORRECTLY.
C   REQD. IMSL ROUTINES - UERTST
C
C-----------------------------------------------------------------------
```

```
C
      SUBROUTINE VMULFP (A,B,L,M,N,IA,IB,C,IC,IER)
C
      REAL*4   A(IA,M),B(IB,M),C(IC,N)
C                                          FIRST EXECUTABLE STATEMENT
      IF (IA.GE.L .AND. IB.GE.N .AND. IC.GE.L) GO TO 5
C                                          TERMINAL ERROR
      IER = 129
      GO TO 9000
C                                          ROW INDICATOR
    5 IER = 0
      DO 20 I = 1,L
C                                          COLUMN INDICATOR
         DO 15 J = 1,N
            TEMP = 0.0
C                                          VECTOR DOT PRODUCT
            DO 10 K = 1,M
               TEMP = TEMP + A(I,K)*B(J,K)
   10       CONTINUE
            C(I,J) = TEMP
   15    CONTINUE
   20 CONTINUE
      GO TO 9005
 9000 CONTINUE
      CALL UERTST (IER,6HVMULFP)
 9005 RETURN
      END
```

MIDAS FORTRAN IV   STORAGE MAP

NAME	OFFSET	ATTRIBUTES		
A	000014	REAL*4	PARAMETER	ARRAY (IA,M)
IA	000026	INTEGER*2	PARAMETER	VARIABLE
M	000022	INTEGER*2	PARAMETER	VARIABLE
B	000016	REAL*4	PARAMETER	ARRAY (IB,M)
IB	000030	INTEGER*2	PARAMETER	VARIABLE
C	000032	REAL*4	PARAMETER	ARRAY (IC,N)
IC	000034	INTEGER*2	PARAMETER	VARIABLE
N	000024	INTEGER*2	PARAMETER	VARIABLE
L	000020	INTEGER*2	PARAMETER	VARIABLE
IER	000036	INTEGER*2	PARAMETER	VARIABLE
I	000050	INTEGER*2	VARIABLE	
J	000052	INTEGER*2	VARIABLE	
TEMP	000054	REAL*4	VARIABLE	
K	000060	INTEGER*2	VARIABLE	
UERTST	000000	REAL*4	PROCEDURE	

END

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